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USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 65

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No. 65

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USSR UDC 669.71:539.52.620.187

ON THE NATURE OF THE SUPERPLASTICITY OF ALUMINUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 6, 1979
pp 1271-1276 manuscript received 10 Aug 78

LIKHACHEV, V. A., MYSHLYAYEV, M. M., SEN'KOV, O. N. and KUZ'MIN, S. L., Leningrad State University imeni A. A. Zhdanov, Institute of Solid State Physics, Academy of Sciences USSR

[Abstract] The presence of structural signs of the superplasticity of aluminum was investigated in foil samples taken from sharply notched specimens that had been subjected to torsion tests. Electronmicroscopic examination revealed that samples taken from specimens in the original state displayed a dislocation structure with occasional cells represented by clusters of dislocation, whereas samples taken from specimens subjected to superplastic deformation by means of torsion tests at room temperature revealed a dense cellular structure. Samples taken from specimens deformed at 450°C revealed a subgrain structure in the notch area. It may thus be concluded that in room temperature tossion tests a cellular and weakly disoriented structure gradually forms which results in fragmentation of the metal and, subsequently, as the adaptability of the metal to plastic flow becomes exhausted, leads to the formation of fracture foci which result in the rapid development of a major crack. The mechanism of superplastic deformation at 450°C is more complex. At first wide-angled and sufficiently large subgrains form which later decrease in size as their angles of disorientation increase. The principal stresses of flow and fracture develop not within the cells but at the subgrain boundaries; nevertheless, fracture does not occur owing to the enhanced quasi-recrystallization activity of the metal with the formation of new (secondary) minute subgrains. It is this process that can be regarded as the concrete mechanism of superplasticity. From this ensues the important conclusion that cellularity is not the decisive factor in the superplastic straining of aluminum; such straining is rather governed by the patterns of evolution of another and more coarse structural element--the subgrain structure, regardless of whether the original grain was mono- or polycrystal. Figures 6; references 8: all Russian, including 1 in English translation. [178-1386]

USSR UDC 669.017.3:621:725

EFFECTS OF DYNAMIC AGING AND THE STRENGTH PROPERTIES OF BERYLLIUM

Kiev PROBLEMY PROCHNOSTI in Russian No 8, Aug 79 pp 106-109 manuscript received 14 Jun 78

LASHUK, N. K., TKACHENKO, V. G., KHAMATOV, R. I., ARTEMYUK, S. A., KOLESNIK, L. I. and YUSHKO, V. G., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] TGP-56 beryllium in the initial (sintered under pressure) and recrystallized states was used to study the mechanisms of impurity movement which affect the dynamic aging process and the failure of beryllium. Anomalous strength properties were noted in the 200° and 500°C regions where stress maximums exist. After recrystallization, the maximum at 500° on the stress-temperature curves is suppressed but a maximum at 200° forms simultaneously. During dynamic aging the Be-F and Be-C solid solutions decompose and carbon atoms segregate in structural defects as interstitial impurities for low-temperature aging and as substitutional impurities at high temperatures. Iron contributes to the aging process by narrowing the temperature interval of hot-shortness and allows the transmission of slip through grain boundaries. At temperatures above 500°C there is a change in the fracture mechanism where grain-boundary failure converts into brittle intercellular fracture. It was suggested that the cellular structure develops in a specific sequence during incomplete flow of the metal. During dynamic aging at the higher temperatures dislocations are multiplied at an increased rate along with the cellular structure formation which tends to block slippage and prevent recovery. Figures 5; references 12: 7 Russian, 5 Western.
[4-6368]

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DIFFUSION OF CARBON IN BERYLLIUM OF VARYING PURITY

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, 1979 pp 124-129
manuscript received 29 Aug 77

ZOTOV, V. S., Sverdlovsk

[Abstract] The parameters of the diffusion of carbon in beryllium are known to vary considerably, e.g., activation energy can be as low as 16 and as high as 90 kcal/mole. Acting on the assumption that this is due to the presence of impurities in beryllium, the diffusion mobility of carbon in specimens of cermet beryllium and arc furnace-remelted beryllium of varying degree of purity was investigated. The mean grain size of the cermet beryllium was ∿0.05 mm and that of remelted beryllium $\leq$ 1 mm. A thin layer of radioactive carbon in the form of the isotope C^{14} in Zapon was applied to the specimen, thus providing a constant source of diffusion. The specimens were then diffusion-annealed in a vacuum furnace. Penetration curves were constructed on the basis of radiometric layer analysis, along with measurements of radioactivity. The penetration curves for both remelted and cermet beryllium were in good agreement with the solution of the diffusion equation for a constant diffusion source. Despite the marked differences between the parameters of diffusion of carbon in beryllium, the diffusion process itself probably follows a common mechanism, since the plot of $\ln D_0 = f(Q)$ is close to that of a straight line. No final conclusions on the mechanism of the diffusion of carbon in beryllium can be drawn, but this mechanism should be extremely susceptible to minor changes in impurity concentration and be similar to mechanisms inherent in substitution solutions and should account for the low mobility of carbon in beryllium. Figures 4; references 24: 17 Russian, 7 Western.
[173-1386]

USSR UDC 621.357.7

PROPERTIES OF COMPOSITE CHROMIUM COATINGS WITH A LOW CONCENTRATION OF INTERSTITIAL CORUNDUM PARTICLES

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 5, Sep/Oct 79 pp 619-622 manuscript received 23 Dec 77

PUSHKAREVA, S. A. and GOLOVACHEVA, I. P., All-Union Scientific Research Institute of Railroad Transportation, Ural branch

[Abstract] Since composite chromium coatings with a high concentration of interstitial corundum cannot be produced from the standard electrolyte (250 g CrO_3 + 2.5g H_2SO_4 in 1 liter H_2O), a study was made of such coatings with a low concentration of interstitial corundum. Both the standard and a dilute electrolyte (150g CrO_3 + 1.5g H_2SO_4 in 1 liter H_2O) were used in the experiment, composite coatings being produced by addition of electrolytic-grade E24-A M7 corundum (grain diameter 7 μm) and surface tension reduced by addition of gallic acid. The cathodes were made of bronze foil and the anodes were made of lead foil, their respective surface areas in the ratio 1:2, all inside an electrolyzer of 4 liters capacity. With adequate stirring, the corundum concentration was maintained within 0.2-0.3 wt.% and a final hardness of 150-200 kgf/mm^2 was attained. Specimens with such coatings were tested in dry friction under semi-industrial conditions and in Diesel engines under normal operating conditions. The results indicate an excellent wear resistance and overall antifriction characteristics. To this must be added the advantage of a much shorter chrome-plating process time. Figures 2; references 2 (Russian).
[2-2415]

USSR UDC 620.171:519.24

STATISTICAL INVESTIGATION OF THE STRENGTH OF COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 79 pp 87-90 manuscript received 29 May 78

KALINICHENKO, V. I., KARPINOS, D. M., TSVETKOV, V. N. and MIKHASHCHUK, YE. T., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] A statistical investigation was made into the mechanical property-temperature relationship of cermets (Al_2O_3-Mo, AlN-Mo) reinforced with whisker crystals of zirconium dioxide and mullite. Using mathematical models the strength characteristics of these cermets were studied in relation to their impact, bend and compressive strengths. Calculations showed that the strength characteristics of these composites decrease with increased temperature. At the start of the high-temperature range the strength of the Al_2O_3-Mo cermet was higher than the AlN-Mo while at 1000-1400° they were approximately the same in strength with the energy capacity of AlN-Mo in the failure process being higher. In summary the dynamic strength of a composite material drops more sharply than during static bend and compression. Figures 3; references 2 (Russian).
[8-6368]

USSR UDC 539.219:678.5.06

EFFECT OF SURFACE TREATMENT OF CARBON FIBERS ON THE STRENGTH CHARACTERISTICS OF CARBON PLASTICS

Riga MEKHANIKA KOMPOSITNYKH MATERIALOV in Russian No 4, Jul/Aug 79 pp 603-606 manuscript received 5 Jul 78

GUNYAYEV, G. M., GORELOV, YU. A., DAVYDOV, YU. A., DERGUNOVA, V. S., KILIN, V. S., NABATNIKOV, A. P., SORINA, T. G., SURGUCHEVA, A. I., SILAYEV, V. A., SHAROVA, A. V. and FROLOV, V. I.

[Abstract] Films of silicon carbide were deposited from the gaseous phase on carbon fibers with a base of polyacryl nitrile, the coating thickness being regulated by the process time. The effect of such a coating on the strength characteristics of these fibers as well as of a carbon-plastic composite material was studied by electron-microscopic examination of the surface defectiveness and measurement of the strength, especially in shear and compression. An optimum coating thickness within the 10-30 nm range on fibers with an average diameter of 6 μm improved the shear strength without affecting the compressive strength. A porous carbide jacket around bundles of carbon fibers not

too thick to prevent adequate impregnation with a binder such as epoxy may provide the basis for a new type of composite materials with better mechanical characteristics. Figures 7; references 7: 2 Russian, 5 Western.
[10-2415]

USSR UDC 539.4:678.5.06

ANALYZING THE DYNAMICS OF COMPOSITE-MATERIAL STRUCTURES BY THE METHOD OF SUPERELEMENTS

Riga MEKHANIKA KOMPOSITNYKH MATERIALOV in Russian No 4, Jul/Aug 79 pp 652-655 manuscript received 14 Feb 79

VOL'MIR, A. S. and TERSKIKH, V. N., Moscow

[Abstract] Application of the method of finite elements to analysis of the dynamics of composite-material structures is mathematically difficult, because a dense grid of elements is required and a high-order system of algebraic equations results. Here the method of superelements was applied, with the structure regarded as a set of substructures. The dependence of the natural frequencies and modes of the entire structure on those of its substructures was calculated, for illustration, in the simplest case of two such superelements. The equation of motion, without damping, was formulated in matrix form and solved accordingly. The accuracy of the results depends on the number of vibration modes retained in the calculation. The method was further applied here, with calculations based on three superelements, to a structure built of a composite material in the shape of an airplane. The method was found to be very effective for isotropic as well as anisotropic structures, especially when calculations can be programmed on a computer so that more modes can be easily included in the analysis. Figures 4; references 4: 3 Russian, 1 Western.
[10-2415]

USSR UDC 621.762:620.17

STRENGTH OF COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 79 pp 22-26 manuscript received 8 Jan 79

YEGOROV, F. F., KISLYY, P. S. and VERKHOVODOV, P. A., Institute of Problems of Material-Science, Academy of Sciences UkrSSR, and Institute of Super-hard Materials, Academy of Sciences UkrSSR

[Abstract] A study was made of the strength of $ZrN-Al_2O_3$ composites which were produced by solid- and liquid-phase sintering in argon and in nitrogen. It was shown that the strength of composites sintered in nitrogen is significantly lower than those sintered in argon, which was linked with the formation of new phases at the interphase boundaries and a weakening of the bond between the components. The strength of composites produced by liquid-phase sintering is lower and occurs after solid-phase sintering, which was explained by the intense interaction of the nitride with the formation of zirconium dioxide at the boundary phase at high temperatures. The strength of materials with a low content of aluminum oxide depends on the thickness of the oxide layer between the strengthening grains. For a significant quantity of aluminum oxide the strength of composites depends on the bonding strength at the interphase boundaries and boundaries of the univariable phases. With increased size of the matrix grains and strengthening particles, the strength of composites starts to increase but then drops off. Figures 3; references 9: 8 Russian, 1 Western.
[8-6368]

USSR

ALL-UNION CONFERENCE ON THE METALLURGY OF TITANIUM

Moscow TSVETNNYE METALLY in Russian No 8, Aug 79 pp 115-116

MOROZOV, A. A.

[Abstract] An All-Union Conference on the Metallurgy of Titanium was held in Moscow on 14-15 May 1979. This conference was convened at the Institute of Metallurgy imeni A. A. Baykov and organized by the scientific council on the Physicochemical Foundations of Metallurgical Processes at the Division of Physical Chemistry and Technology of Inorganic Materials, Academy of Sciences USSR. V. S. USTINOV, Deputy Minister of the Ministry of Nonferrous Metals, opened the conference. A. N. PETRUN'KO (Institute of Titanium) gave a report devoted to analysis of the modern state and prospects of expanding the production and use of titanium. V. A. REZNICHENKO (Institute of Metallurgy--IMET) discussed problems of metallurgy of complex titanium-containing ores and their solution using energy of atomic power stations. V. A. BLINOV (VIMS--All-Union Scientific Research Institute of Mineral Raw Materials) noted the state and prospects of expanding the raw material base of titanium. In the papers of S. V. OGURTSOV (GIREDMET), R. A. SANDLER (Leningrad Mining Institute), I. A. KARYAZIN (IMET), D. L. MOTOV (Karaganda Affiliate of the Academy of Sciences USSR), and A. P. SINENKO and N. A. PAMPUSHKO (Institute of Titanium), investigations were reported into the various direction of titanium metallurgy. A. I. VOROBEYCHIK (Chelyabinsk Affiliate of NIPROINS) reported on the problem of creating mass production of pigmented titanium dioxide using titanium slags. S. G. GLAZUNOV established scientific and practical problems in the area of titanium alloy technology. N. F. ANOSHKIN (VILS --All-Union Institute of Light Alloys) disclosed development of new effective technological processes for producing titanium alloy ingots and semi-finished products. YU. M. PRILUTSKIKH (VSMOZ) characterized the state of work on the technology of melting and treating titanium and titanium-base alloys. I. S. POL'KIN (VILS) devoted his report to problems of optimizing the technological parameters in the process of titanium-alloy production for the purpose of improving structure and increasing the operational properties of the finished product. O. P. SOLONIN (VIAM--All-Union Institute of Aviation Materials) reported on the principles of alloying and areas of using titanium alloys. P. B. BUDBERG and O. K. BELOUSOV (IMET) reported results of work on titanium alloys with special physical properties and on developing new corrosion-resistant alloys. YU. G. OLESOV (Institute of Titanium) noted developments in powder metallurgy of titanium. The welding of titanium and its alloys was noted in the report of S. M. GUREVICH (Institute of Electric Welding imeni Ye. O. Paton).
[9-6368]

USSR UDC 620.194

CORROSION-MECHANICAL CHARACTERISTICS OF ALUMINUM-ALLOY PANELS

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 15 No 4, Apr 79 pp 99-100 manuscript received 6 Jun 77

STEPANOV, I. A., BAKULIN, A. V. and KOBZARUK, A. V.

[Abstract] Molded panels with reinforcing ribs made of an aluminum alloy with Zn:Mg $\sim$0.5 have been found to be prone to corrosion cracking on the reinforced side but not on the smooth side. A study was made to determine the variation of corrosion-mechanical characteristics over the panel thickness. Specimens cut from a panel by the electric erosion process were treated with a 3% NaCl + 0.1% H_2O_2 solution under a constant tensile load for 60 days to establish the maximum safe stress level and under cyclic loads for 5 min. In the latter case the load was varied either sinusoidally at a frequency of $1.7 \cdot 10^{-3}$ Hz or trapezoidally at frequencies lower than that. Below this frequency the direction of crack propagation changed through 90° and foliation occurred after fewer cycles. A subsequent layerwise microstructural examination revealed a fine-grain structure with an orientation in the direction of deformation on the reinforced side. Under a constant bending load, alternating immersion of panels in a 3% NaCl solution was found to appreciably decelerate cracking upon treatment to a depth of about 0.1 mm and to almost completely inhibit it upon treatment to a depth of over 1 mm. Figures 2; references 4: 3 Russian, 1 Western.
[11-2415]

USSR UDC 620.193.2

ATMOSPHERIC CORROSION OF METALLIC SYSTEMS, PART 3: CORROSIVE BEHAVIOR OF ALUMINUM ALLOYS AND A MAGNESIUM ALLOY UNDER VARIOUS ATMOSPHERIC CONDITIONS

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 5, Sep/Oct 79 pp 523-532
manuscript received 21 Mar 79

MIKHAYLOVSKIY, YU. and SKURIKHIN, A., Institute of Physical Chemistry, Academy of Sciences USSR; CERNY, M., State Scientific Research Institute of Metal Protection imeni G. V. Akimov, Czechoslovak Socialist Republic; BELES, R., Design Institute of General Machine Construction, Hungarian People's Republic; SEIDEL, M., Center for Corrosion Protection, German Democratic Republic

[Abstract] A study was made concerning the corrosion resistance of the D16T, 0915, AMG-6 aluminum alloys and of the MA2-1 magnesium alloy in various climates, under the sky or inside a louvered shed, for the purpose of determining the dependence of the corrosion rate on meteorological and aerochemical characteristics of the atmosphere. Specimens 100 x 150 mm (0.9-1A mm thick) were cut from sheet metal and properly heat treated before testing. Testing took place during the period 1969-76 in seven locations: Zvenigorod (USSR, rural atmosphere), Moscow (USSR, industrial atmosphere), Prague-Letniani (Czechoslovakia, industrial atmosphere), Usti-on-the-Labe (Czechoslovakia, industrial atmosphere around a chemical plant), Batumi (USSR, maritime atmosphere), Orgovan (Hungary, grassland atmosphere) and Sarafovo (Bulgaria, maritime atmosphere). Corrosion occurred within the approximately -7 to +25°C temperature range, with the presence of sulfur dioxide and chlorides particularly contributing to the process. Corrosion effects were examined in terms of loss of mass, corrosion products, cracking (pitting) mode and change in mechanical properties. The corrosion rate depended nonlinearly on the climatic factors, and an empirical formula was derived on the basis of all available data. The aluminum alloys are less resistant inside a shed than in open air, and less resistant in open air with high SO_2 concentrations. Corrosion of the magnesium alloy in open air is almost independent of the degree of air contamination and is determined by the life of phasal water films. Its high corrosion rate in Batumi is not yet understood. Figures 4; references 13: 6 Russian, 1 Polish, 1 German, 5 Western.
[2-2415]

USSR UDC 620.193.8

EFFECT OF BIOGENIC SUBSTANCES ON THE CORROSION OF METALS IN THE BLACK SEA

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 5, Sep/Oct 79 pp 582-584
manuscript received 24 Jul 78

ULANOVSKIY, I. B. and YEGOROVA, V. A., Institute of Oceanology imeni P. P. Shirov, Academy of Sciences USSR

[Abstract] Corrosion of carbon steel (St3), aluminum (AV-000), an aluminum-magnesium alloy (AMg-6), copper (M1) and brass (L63) in the oxygen zone of the Black Sea was studied, this zone containing the principal biogenic substances (metasilicic acid, phosphates, nitrates and nitrites) in solution. Corrosion tests were performed in three solutions. The control solution was surface water depleted by photosynthesis. The other two solutions of surface water contained Na_2SiO_3, $NaNO_3$, KNO_3, and KH_2PO_4, as well as HCl added to restore the original pH level. Quantitative analysis and colorimetry of the solutions followed by corrosion measurements by the loss of mass method revealed that metasilicic acid decreases the corrosion of steel, copper and brass, probably because of the impermeability of protective films of insoluble silicates. A rise in the H_2SiO_4 concentration affects aluminum and its alloy negligibly while the concentration levels remain low, probably also because of the protective action of silicates forming on the metal surface. As the H_2SiO_4 concentration becomes high, however, the corrosion of aluminum and its alloys increases: now the protective alumina film is transformed to an amorphous, much less protective, alumina-silica gel. Nitrates in low concentrations have some protective effect on carbon steel and brass, but no effect on copper, aluminum and its alloys. Nitrites decrease the corrosion of steel, probably owing to their hydrolysis and formation of nitrous acid, but increase the corrosion of aluminum and copper. Phosphates in low concentrations increase the corrosion of brass, but are too weak to influence corrosion otherwise. The simultaneous effect of all additives in their actual concentrations in the Black Sea is to appreciably decrease the corrosion of steel and brass, to slightly increase the corrosion of copper, and to appreciably increase the corrosion of aluminum and especially its alloys. Tables 4; references 15: 12 Russian, 3 Western.
[2-2415]

USSR UDC 620.193.16

CORROSION-CAVITATION CHARACTERISTIC OF EI943 STEEL IN SOLUTIONS OF ORTHOPHOSPHORIC ACID

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 5, Sep/Oct 79 pp 575-577

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[Abstract] Grade EI943 (Kh23N28M3D3T) steel for pumps has been found to be insufficiently resistant to cavitation during pumping of orthophosphoric extraction acid. Therefore, an experimental study was made of its behavior and electrochemical characteristics under such conditions. Vibrations of a steel specimen were induced with a magnetostrictive device and the potentiometer also served as a waveguide. Hardly any surface passivation was noted during cavitation, indicating a failure to retain protective oxide layers, while the rate of electrochemical dissolution within the passivity range increased by a factor of 40-50. As the concentration of acid was increased from 0.5 M to the commercial level of 12.7 M, the static potential became more positive and the passivity range narrower. The total loss of mass decreased at the same time, while the role of corrosion (chemical wear) increased and the role of cavitation (mechanical wear) decreased. The damping of cavitation is attributed to higher dynamic viscosity. Since the cavitation level is still very high in a commercial acid solution, only replacement of EI943 steel with a more resistant grade will lengthen the service life of pumps, especially in dilute solutions. Figures 1; references 3: 2 Russian, 1 Western.
[2-2415]

NEW TECHNOLOGICAL PROCESSES AND MATERIALS BEING USED IN FERROUS METALLURGY

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/Interview with A. I. Manokhin, General Director of the "Tulachermet" Scientific Production Association: "The Transformation of Metal"/

> /Text/ In ferrous metallurgy in 1980 provide for the production of 160-170 million tons of steel and 115-120 million tons of finished rolled metal.
>
> Significantly improve the quality and expand the assortment of metal products...
>
> "Basic Trends for the Development of the USSR National Economy in 1976-1980"

Metal is the basis of industry.

Metal is very large machine units, high temperatures and the use of powerful electromagnetic fields. Institutes of the USSR Academy of Sciences and branch institutes are proposing new technological processes, materials and principles which are being realized today in metallurgy and which are opening new prospects for the future.

We are discussing the work of the Institute of Metallurgy imeni A. A. Baykov of the USSR Academy of Sciences, the All-Union Scientific-Research Institute of Abrasives and Polishing, the All-Union Scientific-Research Institute of Automation of Ferrous Metallurgy and the Mordovskiy State University.

A. I. Manokin, the director of the Institute of Metallurgy imeni A. A. Baykov of the USSR Academy of Sciences, corresponding member of the USSR Academy of Sciences, winner of the Lenin and State prizes, general director of the "Tulachermet" [Tula ferrous metallurgy] Scientific Production Association, speaks on these matters.

In recent decades two strategic paths in metallurgy have been clearly defined for improving it.

One of these has been the creation of very large machine units with a high degree of control automation and the complete mechanization of auxilliary work. The second is the increased expansion of the arsenal of means which make it possible to raise the quality of metal. However, the size of the machine units not only provides for the growth of labor productivity but also for the improvement in the quality of the product: one can obtain large amounts of metal with uniform properties. This is very important. As concerns the means for influencing metal, the production engineers have at their disposal such new to metallurgy forces as superhigh and superlow temperatures, pulse effects such as the blast shock waves, superhigh pressures and, of course, the vacuum.

The outside of the furnace degassing is particularly appealing as a relatively simple and inexpensive method for improving metal. The essence of this method is that the metal which is obtained in ordinary open furnaces is poured into a ladle, under a special dome, from which pumps begin to evacuate the air. A vacuum is created above the metal which is not very high (this is not so important - simple equipment can be used); but the vacuum forces out the gas admixtures which are contained in the molten metal and the gases can then be easily expelled with the use of the same pumps. As a result it is possible to obtain steels with an entire range of new properties - primarily with an improved pliability.

This quality is particularly important for sheet metal, from which parts that are complicated in form are stamped.

The processing of steel by means of synthetic slags, electroslag and vacuum resmelting are the present of metallurgy. They have made it possible to sharply improve the quality of metal and to obtain steels with truly unique properties. What awaits metallurgy in the near future, say by the year 2000? One can single out three trends from many, which, in our opinion are the most important: constant processes, composition materials and powders.

Constant processes have been firmly established for some time in metallurgy. They make it possible to sharply raise labor productivity and to a large extent to mechanize and automate work and to get rid of manual labor. What is more, no matter how paradoxical it may seem, in metallurgy the constant processes began from the "end" of the technological cycle - with the rolling. In many shops the rolling mills "pull" the wire, sheet and other profiles through the rollers at very high speeds. The process proceeds at such saturated modes that between the completion of the preceding blank and the beginning of the next the gap does not exceed several centimeters.

The pouring of molten steel has also become constant. It has replaced the unproductive and heavy pouring into ingot molds. Soviet UNRS - installations for the constant pouring of steel - have been recognized not only in the USSR, but abroad as well.

The beginning of metallurgical technology, the smelting of pig iron, is actually becoming a constant process. In the new large-capacity blast furnaces one of the foundry gates is constantly turning out pig iron; and this molten river is constantly flowing from the blast furnace shops to the steel smelting shops. An intriguing idea comes to mind - to join together into a single, uninterrupted chain the entire technological cycle and various kinds of metallurgical machine units. In other words, put the pig iron smelting, steel smelting and rolling machine units into a single line so that the metal is constantly passing from machine unit to machine unit, undergoing all necessary changes along the way. But there is still a "white hole" in this orderly chain - the middle link, steel making.

For now there is no steel smelting machine unit, open-hearth furnace, converter or electrofurnace that can operate constantly. Between the loading of the raw material and the output of the finished product there is a passage of time - from one hour for a converter and up to several hours for the open-hearth furnace and the electrofurnace. For many years throughout the world efforts have been made to design a steel smelting machine unit that could operate constantly.

Soviet scientists were the first to succeed. Several years ago at the Zaporozhstal' plant they built a SAND - a constantly operating steel smelting machine unit - which was developed by a collective of researchers headed by Professor M. A. Glinkov. The machine unit was constructed on the basis of an open-hearth furnace, but does not have a single vat, as in the open-hearth furnace, but four, in each of which one of the steel making operations is underway. While being poured from one vat to another, the metal undergoes all technological changes; the finished steel exits from the final vat in a constant flow. Experiments with this machine unit have been very promising. Even more interesting results have been demonstrated by another SAND, which was created at the All-Union Scientific-Research Institute of Metallurgical Machine Building under the guidance of Academician A. I. Tselikov. The scientists made it in the form of a series of converters, where the metal passes from one converter to the next while being converted into a finished steel.

It is not yet known exactly what sort of SAND will win a place in industry. It is clear that the constant production of metal is not far off. It will drastically alter the aspect of metallurgical plants. They will become compact - an entire plant under a single roof. This will mean that inter shop transporting will disappear, the amount of workers will be reduced and there will be a sharp increase in the output of metal.

The second trend is composition materials, or simply composites. The times have passed when basically only strength was required of materials. Today for modern machinery, mechanisms and instruments materials must possess many properties, which at times would seem to be mutually exclusive. For example, both strength and pliability. It was not so long ago that this problem would have been thought to be unsolvable. Now the metallurgists are taking, as an example, not the most durable, but a sufficiently flexible material as a basis and injecting strengthening particles into it. Or, the other way around, they are taking a durable material and injecting softening particles into it. As a result in both cases they are obtaining somehow metals with a filler, which furnishes them with the deficient properties.

Durability is not the only concern. Let us say that we need a metal with a high heat tolerance, but which is relatively lightweight. Then we can take a tungsten and inject light weight fillers into it. A "shell" made of tungsten will withstand high temperatures and the specific weight is less. There are many such variations. Composition materials have a big future.

Manufactured articles made out of metallic powders have no less of a future. The technology for manufacturing them is simple: the powders are compacted and then agglomerated in the furnace at a high temperature. Lightweight and durable manufactured articles are obtained, which require no further processing. A thousand tons of iron powder provide a savings of 1,500,000 rubles, and moreover one can sharply decrease the number of workers engaged in production.

The greatest impact is made by powder metallurgy, if alloy powders are used. Let us say that a high-speed cutting steel requires tungsten. Powder metallurgy makes it possible to create a bimetal instrument, which requires tungsten only for the working surface - the rest of it can be made out of regular steel. This means that we will conserve hundreds of thousands of tons of tungsten, vanadium and molybdenum.

This is only one example, but thousands could be cited. The most important thing is that at present, based on the classical three-stage conversion, we are able to obtain totally new materials with a broad range of unique properties. And in the future, when the "classical" technology is replaced by essentially other methods for obtaining metal, the range of these materials will broaden beyond measure.

OMD Hybrids - Uncommon Mills

Any housewife knows how much easier it is to roll out dough when it does not stick to the table. This same rule applies to rolled metal. It is precisely the forces of friction, which arise on the touching surfaces of a machine and the ingot, that serve as the chief impediment to the desired deformation. Of course, one must not forget about the properties of the material itself. It is unquestionably easier to hammer out a pliable lead than a steel, for example.

It comes as no surprise that the history of rolling is firmly tied with the unending search for a modern lubricant. At one time they used pig skins with a thin layer of subcutaneous fat for this purpose.

Scientific-research institutes are presently engaged in the search for new lubricating materials. At present all known lubricants are far from perfection and are not inexpensive. There is an uncommon trend underway in the search: replacing the lubricant with low-frequency oscillations (vibrorolling). Hopes were placed upon ultrasound. Alas! It is not so simple and safe to transmit vibrations to the rollers and the ingot.

The rolled metal workers have their problems. The specialists of another method for processing metals by means of pressure (abbreviated as OMD) - have their own problems. But, as we shall see later on, the two "sets" of problems can be solved jointly.

You have more than likely had an opportunity to admire ancient parade uniforms that are decorated with gold and silver braids. Some of these outfits weigh several poods [pood = 16.38 kg]. The thread from precious fibers was acquired by painstaking labor. First the goldsmiths cleverly, but carefully formed the bar out of an ingot of the precious metal. Then the slightly sharpened point of the bar, literally in the eye of the needle, was fed into an opening, which had been made in a cast iron plate. By means of adroit snips the strongman-assistant pulled (dragged) the entire ingot through the opening. The thread was pulled and became thinner. The operation was repeated, using the next opening - a hole somewhat smaller. This continued until the gold thread did not lie in the skein - the rival of a scarcely noticeable spider web.

The wire-drawing machine has taken on this most laborious task, having substantially multiplied its productivity. Modern draw benches stretch copper for trolley-bus lead-in wires; aluminum threads, from which multiple wires are braided; and steel wire, without which many branches of the national economy could not get along.

Only the draw bench has preserved the antiquated principle of processing metal. Using the same little hole or, to express it in modern parlance, a draw plate. The drawing plate is an extremely simple instrument, which presses by its sides the endless skein of the semifinished wire, of the so-called wire rod that is obtained on special rolling mills. Again the harmful forces of friction come into play, constantly attacking the instrument. And again the problem of lubrication comes to the surface. The working edges of the draw plates must be made out of the most durable alloys which are impervious to the abrasion of hard alloys. Even from diamonds that have previously been pierced by a laser ray. Expensive and not as long-lived as one might want. But what is one to do?

Doctor of Technical Sciences, professor and honored scientist of the RSFSR, Vladimir Nikolayevich Vydrin heads the department of OMD of the Chelyabinsk Polytechnical Institute. The machines that are created here are not only original, they conceal within themselves solutions that are paradoxical and absolutely unusual.

From time immemorial rollers have turned toward each other at a strictly observed identical speed. The upper roller rushes to crush the ingot. The lower roller serves somehow as the moveable support. The full strength of the machine is directed at the gap between the rollers. Such is the classical diagram for the arrangement of the primary forces in metal rolling. The forces are such that the working stands of rolling mills are as tall as a building of several stories and weigh hundreds of tons.

But why not use a law known to every schooboy in regard to these mastodons of technology: the power is equal to the product of a force against a path. Vladimir Nikolayevich decided to violate the indisputable law of metal rolling and designed a model, in which the speed of revolutions of one of the rollers was sharply slowed. The strip of metal, as might have been expected, immediately buckled and stuck to the surface of the more rapidly moving roller. In common metal rolling such a situation would be considered almost an emergency and causes unavoidable wastage. In the model several pairs of rollers were installed in one stand. And around each of them, just as a serpent crawling through a winding and cramped labyrinthe, a metallic tape was wrapped. The surface where the rollers touched the tape became considerably greater. The forces of the cohesion were also increased considerably. But the forces of friction, against which they had fought, were not present. Now friction performs the role of the tongs of a skillful apprentice; friction does not hinder but, on the contrary, helps to pull the metal through the rollers! And the rollers themselves operate in accordance with the system of the drawing process. They are somehow both draw plates and tongs at the same time.

The original thickness of the tape-ingot is about the thickness of a common notebook. A thin crepitating strip of metal, almost without any density, is placed on the take-in coiling machine. The effect such as I saw in Chelyabinsk in the problem solving laboratory of the polytechnical institute has not been obtained in a single rolling mill. The scientist has named his creation the "PV mill" - rolled metal - drawing. Processes, which never before had been combined, were joined into a single whole.

The discovery promises much. The hybrid process substantially conserves energy and makes it possible to discontinue building giant mills. The productivity of the equipment is raised sharply and, most important, it provides for the output of a higher quality product.

Everything in the new machine is harmoniously combined and it proceeds for the common good. The tape is bent in the rollers... What advantage can be derived from this situation, that was previously considered intolerable? Use your imagination - a considerable advantage can be gained.

In a metallurgical production facility there are so-called constant etching machine units, in front of which mills are installed; the constant etching machine units' purpose is to remove scale from the strip. They usually handle their assigned role poorly. But then on PV machines the scale flies off with a characteristic decrepitation on the sudden bend of the first pair of rollers.

The PV process has already received blessing at Soviet and foreign enterprises. The Novosibirsk metallurgical plant imeni A. N. Kuz'min, where a PV-800 mill was built and is now being adopted, is primarily deserving of mention. This mill was given the honoured task of subjugating alloys of corrosion resistant steels and won for those who have it the reputation of being among the most labor yielding.

But this is not the end of the miracle of "metallurgical hybridization".

No matter how important metal rolling and drawing are, without the parts that are obtained by the forging, one cannot assemble a single modern machine, be it a combine, an automobile or a jet airliner. Sometimes the forge work and the stamping comprise almost half of the total weight of a machine. The advantage of the hammer is that with its use one obtains parts of almost any form. And besides in one case the services of forging are needed for the preliminary compacting of the metal.

It is rare for any production facility to get by without forging. The blacksmith has a particular honor. His work is not easy. The crash of hammers, the harmful vibration, the heat blazing from the apertures of the furnaces for the repeated heating of the metal. In Chelyabinsk they have managed to conceal this process as well in the rollers. The inventor of this new procedure is a student and follower of Vydrin, candidate for the degree of doctor of technical sciences Yevgeniy Nikolayevich Berezin.

Yevgeniy Nikolayevich has augmented the design of the PV mill with one more pair of rollers - vertical. The metal that is compressed from all four sides simply has no place to hide. Except into the specially planned grooves that are cut all the way around the roller. For the experienced rolling-press operator such a process for forming metal seems to be a fantasy. A strip or, let us say, a cylinder is fed into the mill. And whatever you want is obtained: a rhombus, a square or all the way to the most complicated polyhedron reminding one in its features of a snowflake. The workers of the Chelyabinsk metallurgical plant have managed to manufacture an entire batch of very complicated in profile coils. And what is more they were able to conserve almost a third of the costly alloyed steel.

The strip of metal that has fallen into the "frame" from the four rollers experiences such a powerful force influence that it is unable to resist the blow of the large hammer. And the structure of the rolled metal that is obtained is ideally dense - without empty spaces and shallow pockets, as a rule, being nested in the body of the ingot.

In the new PK (rolling - forging) assembly one can obtain an entire family of bars of almost any profile from one ingot. Including a high precision thin wire. Several years ago this was obtained by overburdening subsequently two large enterprises. First in Chelyabinsk they rolled a round cross section ingot. Then the heavy coils of the semifinished rolled wire were loaded on railroad cars and transported to far-off Konstantinovka, where the production was completed on unique drawing machines.

> [Insert] Invention No. ...
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> Steel is improved from within, when loading a capsule with alloy elements into the molten metal; the capsule is destroyed at the necessary moment by ultrasound which passes through the melt. The method is especially convenient when smelting high grade steels in a vacuum. (Invention No 487133)
>
> Heat is not lost to no avail when it is radiated by a cooling pig iron ingot. The flow of heat is directed backwards, having surrounded the ingot with screens. This prevents its rapid cooling, which is harmful to the structure of the metal. The method is recognized by invention (No 495147).
>
> A brick with new properties is obtained by stacking it into a foundry form and pouring it as a molten metal. In this manner one can make refractory units for the fettle of metallurgical furnaces. This is an invention of the Orsko-Khalilovskiy metallurgical combine (No 495513).
>
> In order to reduce the noise of a grinder that is crushing ore, it is necessary to place rubber chambers on its cylindrical housing and blow them up with air. The rubber-air damper is invention No 483130.

Forge the Iron in a Magnetic Field

Forging iron in a magnetic field is another new, revolutionary principle. The pulse magnetic field stamps without heating, without noise, without scale and without errors. The condensor stores electric energy, instantaneously discharges through an electromagnetic inductor ("coil"), and a powerful magnetic field deforms the metal as a piece of modeling clay. Magnetic-pulse stamping has been adopted at many enterprises and continues to be improved. But this is stamping. How would it be with rolling or drawing? The rollers of rolling mills and the draw plates of drawing mills influence metal over a long period of time, gradually. In this case one can do nothing by means of pulses.

At the Cherepovets branch of the Northwest polytechnical institute, in the electrodrive laboratory, for several years they have been doing research on the deformation of steel wire using ferromagnetic powders. Powders rather than super hard alloys. Let us imagine a wire as a multitude of cylinders, inserted into each other without a gap. The wall thickness of these little cylinders let us set at no greater than interatomic distances. We will attempt to pull out the inner cylinder from this collection of cylinders. It cannot be done! It is necessary for someone to brake and to clamp down on the outer cylinder. This is the way it is with wire. It is necessary to compress the outer layer of the wire from all sides - to brake it. The outer layer brakes the layer-cylinder just beneath it, and that layer brakes the next layer and the same for the rest of the chain with diminishing force. And now the little cylinders will move like the sections of a telescope. This is drawing. The "someone" who holds the outer layer of metal in a drawing mill is the hard alloy drawing plate - a hunk of metal weighing several grams. Up to 30,000 kilocalories per hour are exuded in it when drawing.

Perhaps holding the wire not in a hard alloy "fist" of the draw plate, but in something a bit more delicate? This would be something essentially new.

The researchers compressed the wire with iron powder. The wire moves through the mass of powder completely freely. But the magnets located around the chamber with the powder must be included; the powder as an iron powder, while hardening under the influence of the electromagnetic field, is "absorbed" into the surface of the wire and compresses it from all sides. And here magnetic forces are joined with purely mechanical forces of friction. As the wire moves through the powder it intersects the magnetic force lines and, just as any conductor moving through a magnetic field, forms its own magnetic field, which prevents it from moving forward. The mechanical and electromagnetic forces do a good job of clamping down on the same outer cylinder of the steel "telescope" and become a reliable brake, without which drawing is not possible. But this not a brake that has frozen up in its own force of the hard alloy drawing plate, but a flexible brake that is subject to the laws of electromagnetic induction. One can change the force of electromagnetic pressure on the surface of the wire. One can, while changing the form and direction of the magnetic fields, create round, square, polyhedron and any other form of "magnetic drawing plates". Or one can make a square wire from a round one or vice versa, which can be done on common mills only after several stages of drawing.

It is easy to draw off heat from the surface of iron powder, which means that one can increase both the speed of stretching the ingot and the degree of its compression. And both the productivity and the quality of the drawing are improved.

The research continues. But even today one can use the new method in conjunction with traditional ones to clean scale from hot rolled wire. One can use a magnetic field and abrasive powder in place of harmful and bothersome etching. By the way, pure metal dissolves with scale and is wasted during common etching.

The "Edible" Polishing Wheel

The copper coin that is cleaned to a shine, the tourist's smoky teapot that has been transformed by the river's sand, the pebble created by the sea's waves and the shiny steel shaft - this has all been done by polishing. It has been around for a long time. And always this process has wasted both the metal that was removed and the abrasive. Even jewellers lose gold along with the polishing dust.

In the metallurgical industry polishing wheels are used in processing ingots before they are fed into the rolling mills. Various defects are removed from the surface of the ingots. One can, of course, use gas torches or cutters for this, but it is better to remove the defect from the surface of the ingot with an abrasive. This is the most precise and "sparing" method of processing, but it does have one unpleasant aspect: in processing a material, the abrasive itself wears intensively and contaminates the metal shaving so that it cannot be put into the resmelting. And new rounds cannot be made out of the polishing wastes because they have been contaminated by the metal dust. The wastes are harmful to each other. The losses are significant in both a material and economic sense. Hundreds of millions of rubles worth of iron, nickel, cobalt, tungsten, chromium, vanadium and other valuable elements are discarded with the wastes of polishing processing.

Polishing without waste - this is the task that the workers of the electrometallurgical plant "Elektrostal'", the All-Union Scientific-Research Institute of Abrasives and the Moscow Polishing Articles Plant took upon themselves.

The first success and original solution of the complicated problem was an abrasive material which, when cutting metal, does not contaminate the metal shaving. On the contrary, it makes the shaving into a useful additive for the smelting of metals. Silicon carbide was such a material, which is nearly as hard as boron carbide - the hardest abrasive material. It is simply amazing that silicon carbide was never before used for polishing rolled ingots. For silicon is the basic deoxidizing agent for smelting metal.

The first waste-free polishing wheels were made out of silicon carbide. When several wheels had been worn out, the shavings were collected and added to the melting stock in place of ferrosilicon and a laboratory melt was made. The steel that resulted was good. The waste was added to the category of the useful additives.

The problem of utilizing abrasive shaving was solved, but there remained one more problem - the use of the remainder of the abrasive wheel itself in metallurgical production.

The wheels that are used in metallurgy for processing ingots are larger than those used in machine building plants: they have a diameter of a half meter and more. But they can be used only until the diameter has been reduced by a third, at which time the wheel is replaced by a new one. Then another rather simple idea came along - to not make the entire wheel out of the scarce abrasive material. It is better to make the core out of something else. But this "something" had to be such that the processed wheel did not end up in the dump, but was returned to the metallurgical processes. They decided to make the core out of ferroalloys - ferromanganese, ferrotungsten, ferrovanadium and so forth, which are added to almost any melting stock in a fair amount for the smelting of steel.

Slices of bread served as plates before the plate was invented. Such a plate, soaked in fat and sauce, made it possible to conclude a meal. Nothing fell. The principle of the "edible plate" is fully applicable to the new polishing wheel as well. After it has been used for its primary purpose, the polishing wheel is "eaten" for the smelting furnaces.

Thus, the metallurgists have taken the first, but important steps toward creating a new technological process - waste-free polishing.

"Meton" - Such a Word Is Not Yet in the Dictionaries

> Meton is a "relative" of meteorites. Meton can be used to substitute metals and reinforced concrete. But it is considerably cheaper than both.

Meton is metal concrete [metallobeton]. But it is not ordinary reinforced concrete. No, it is a cooled mixture of molten metal and crushed rock, gravel and sand. Meton is more similar to a meteorite substance, in which resmelted minerals and metals have cooled. Perhaps, meteorites led the inventors from the Mordovskiy State University and the Moscow Institute of Railroad Engineers (the manager of the work was Doctor of Technical Sciences and professor, V. I. Solomatov) to the idea of creating something similar artificially. In any case, some metons are equal to the "heavenly" material in their capacity to resist atmospheric influences; their resistance to heat is greater than earth concretes; their durability to compression is greater than the durability of metal contained in them and considerably more "solid" than this indicator for common concretes.

Metons can be aluminum, steel, titanium, pig-iron, lead and tin with fillers of basalt, quartz, granite and sand; light metons consist of claydite, tuff, pumice and low melting metals and alloys. With each new invention the bouquet of the remarkable properties of the new material becomes clearer.

We have meton thin, delicate and light-weight slabs of aluminum and sand - suspended ceilings (previously no one had dreamed of making suspended ceilings out of concrete). They are considerably cheaper that if they were made out of thin steel or duralumin since they contain only one third metal.

Where can one now encounter "pig iron patterned fences"? In the new areas of mass construction they are putting up gray concrete posts that are covered with rusty spots from the iron reinforcement. But from pig iron concrete one can pour "lace" to the envy of the ancient fences.

From lead meton one can make good protective screens for x-ray cabinets, line the walls of various radiation chambers - and such a lining will again be considerably cheaper than lead.

Metons resist compression well, which means that they can be used to pour the mounts of heavy machine tools and presses, on which a fair percentage of the metal that is smelted in the USSR is now expended.

At potassium combines salt "consumes" reinforced concrete columns in four years and asbestos cement ceilings in a year. Metons will be able to resist salt corrosion considerably longer.

How are metons made? Rather simply. A filler, which has been heated somewhat lower than the temperature of smelting, is put into a form and then it is poured as a molten metal. The well-known electroslag resmelting process is used, whereby the electrodes that are expended from the metal will be smelted simultaneously with the mineral ingredients. By this method it is possible to obtain articles of almost unlimited length.

The new material will make any construction reinforced concrete structure considerably lighter in weight. From it one can successfully and considerably cheaper make... We place a series of dots at this point. Meton is a material of unlimited possibilities. More than likely the active readers of our magazine will find new uses for meton in a wide range of production undertakings.

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ADVANTAGES OF HIGH-STRENGTH IRON NOTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 234, 11 Oct 79 p 2

[Article by A. Lebedev, Candidate of Economic Sciences, Lecturer at the Gor'kiy Polytechnical Institute imeni A. A. Zhdanov, Gor'kiy: "The second stage of incorporation"]

[Text] In a construction material such as high-strength iron, the merits of steel (plasticity) are wonderfully combined with the merits of iron (good flowability). This material fills the mold and thinner ingots are produced than are possible with steel. Specialists know what an invaluable quality this is: it is possible to produce blanks weighing anywhere from several grams to many tons. This is known as 'untied hands' in designer circles--design any part you like. Furthermore, parts made from the new material have increased abrasion and corrosion resistance.

The favorable union of such properties makes high-strength iron (HI) an effective replacement for gray iron and malleable iron, carbon steel and, in certain instances, even for alloyed steel. Thus, using it instead of gray iron, it is possible to reduce the weight of ingots by 40-50 percent, with a simultaneous increase in its service life. For example, ingot molds for casting steel will sustain twice as many "fillings" if they are made from HI. In 1980 it is planned to cast about 140 million tons of steel in ingot molds. To do this will require 3.5 million tons of ingot molds made from gray iron. If they are made from the new material, we will save 1.5 million tons of the metal, and this represents additional steel and rolled metal.

The use of HI instead of rolled steel or forgework in particular promises enticing prospects. The Gor'kiy plant "Dvigatel' revolyutsii" has already been fabricating crankshafts for certain diesel engines not from steel but from iron. What has this produced? The coefficient of metal use has improved from 0.23 to 0.70, the shaft itself has "slimmed down" by 800 kg, and its cost has been reduced by 1000 rubles. The use of high-strength iron for water and sewage pipes promises much: they will become more miniaturized, they will resist hydraulic shock better and they will resist rusting for a longer time.

As we see, HI has adequate merit. The "new-born" (and it is just so from the point of view of the history of metallurgy) has justified the hopes and immediately found application in various sectors of the national economy: machine tool building, the automobile industry, heavy machinery building, etc.

The scientific base has been created and is developing. It is the Institute of Casting Problems, Academy of Sciences UkrSSR, TsNIITMASh [Central Scientific Research Institute of Machine Building Technology], the foundry departments of VUZ's and departments of industrial scientific research institutes. Here, work on further study of the properties of the advanced material and improvement of the technology for producing parts is continuing.

There are definite achievements, and there was a time when the growth rates in the production of HI ingots were high and led the way. Our country occupied a leading spot in the world in this area for several years. Gradually the foremost positions were lost and high-strength iron came to be a "stepchild."

Why did this happen? The fact is that in the initial period, when HI was just being mastered, a rather widespread opinion existed that it was easy to produce: all you had to do was throw a piece of magnesium into the melt and there you have it. The miracle iron! Therefore production of ingots made from it was organized in the gray iron (and less frequently, in the malleable iron) workshops. In actuality, the "new-born" had whims that had to be dealt with.

In order to obtain a high-quality product from it, it was necessary to insure that there be as little sulfur as possible in the initial liquid metal, a feat which was impossible to achieve in the gray cast iron workshops without supplementary processing of the metal or without using electrosmelting. The technology was more complex and had more variants than the traditional technology. The result of this was supplementary expenses and increased costs. This, of course, discourages people from using the new product: the economic indicators fall. Thus it was, for example, at the Berdyansk agricultural machinery plant where HI ingots were being produced in the malleable iron workshop.

What is the result? The production of HI ingots should be specialized. Fabricating ingots from malleable iron has been specialized since its discovery. But the specialization should be joined with a concentration based on intersector cooperation. The need to do this is dictated by the fact that the needs of an individual enterprise for parts made from the new material may not be so great. Here are some examples. The Ministry of the Machine Building and Tool Industry has minisectors consisting of a few enterprises, and among them you will not find a single plant where high-strength iron will be produced in quantities of even 10 thousand tons per year, and this is the precise quantity at which the new product becomes profitable. But how much of the metal do these tiny sectors smelt? From 25 to 1,300 tons per year. On the surface, it is a diffusion of means and efforts. The picture is no better in other industries. That means that "Tsentrolity [Central casting plants]" are necessary.

But now, even the specialized high-strength iron foundry shops in our country can, as they say, be counted on your fingers: at the GAZ [Gor'kiy Automobile Plant], the VAZ [Volga Automobile Plant] and several other enterprises. There they understood what the new product promised and are expanding production. Let us say that a new shop for production of HI ingots is being built at the Gor'kiy Automobile Plant. Its construction is in full swing. The parts product list was for 10 thousand tons, and it has now been expanded four-fold. This is one-sixth of the total volume of high-strength iron production throughout the country. The remainder falls to a multiplicity of other plants of various ministries. What a state of fragmentation!

An analysis shows the following: it is particularly expedient to use HI for new parts, incorporating this metal in the design stage for machinery and individual items. Then we will succeed in taking its merits into consideration and using them more fully to create a part with a more efficient form and weight. But not only the part itself, but the remaining parts working with it. The simple replacement of parts in old things frequently has no effect since it permits neither the design nor the industrial advantages of high-strength iron to be realized to their full extent.

Another restrictive reason is the imperfection of planning and evaluation of the works of the foundry shops. The notorious "ton" has even set a backheel to high-strength iron. It is possible to reduce the weight of the ingots by replacing other alloys with it, but then the production volume is reduced. Since the plan for foundry shops is still set in tons, they show a low yield. In accordance of the decree of the Central Committee on the CPSU and the Council of Ministers, USSR "On Improving Planning and on Intensification of the Effect of the Economic Mechanism on Increasing the Efficiency of Production and Work Quality," in the eleventh five-year plan, these deficiencies in the evaluative indicators will be corrected. But now it is time to smash these encumbering barriers.

In our view, machine builders may painlessly refuse planning on volume for production of HI ingots in tons. It is more expedient to establish a coefficient of the applicability of parts made from high-strength iron among the number of quality indices for machine designs, i.e., to specify its use in new technology without fail. This will make it possible to determine the consumption of the material not only in the current period but also in perspective and to specify capabilities in accordance with demands. It will also be possible to establish the portion of the total volume for individual articles (ingot molds, rollers, pipes, domestic bathtubs, etc.) to be made from high-strength iron.

Practice has confirmed the efficiency of using high-strength iron, and it has shown that there are no technically insurmountable problems for developing production of ingots from it. High-strength iron is an important reserve for reducing the metal consumption of machinery and products, for increasing their service life and, a fact which is very important, for saving metal. It is a deep-seated reserve of a kind, one which should be put into operation on a broad scale.
[16/9194]

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SOME ASPECTS OF THE INTRICATE RELATION BETWEEN THE PERFORMANCE OF SOLID LUBRICANTS AND THE VACUUM LEVEL

L'vov FIZIKO-KHIMICHESKAYA MEKHANIYA MATERIALOV in Russian Vol 15 No 4, Apr 79 pp 80-86 manuscript received 21 Dec 77

KURILOV, G. V., Special Design and Technological Office for Electrical Equipment, Kharkov

[Abstract] Solid lubricants composed of the antifrictional filler MoS_2 and a binder have a high specific load capacity over a wide range of temperatures (-200 to +400°C and higher) in chemically aggressive media, in gaseous media and also in a high vacuum. Under the same load pressure and at the same rubbing velocity, the life of lubricant films with an organic binder (NP-212,230) is almost equally long in air and in vacuum, of those with an inorganic binder (NP-229) is longer in vacuum than in air, and of those with an organosilicon binder (NP-213) is longer in air than in vacuum. A study of their performance in dry air and in humid air under pressures down to 10^{-5}-10^{-7} Pa at 25°C was made with an experimental friction pair consisting of a flat ring and a hemispherical slide block so as to provide a near-zero overlap and thus full exposure to ambient conditions. The life and the friction coefficient were measured, with a load of 17,400 kgf/cm^2 and a rubbing velocity of 0.87 m/s, as functions of the atmospheric pressure. The results indicate four ranges with different trends of the respective curves. These trends are interpreted in terms of oxygen and vapor concentrations in the air and their chemical activity with the lubricant. Noteworthy is the constancy of both the life and the friction coefficient throughout the fourth pressure range from 10^{-2} Pa down to ultrahigh vacuum, which makes it unnecessary to test any particular grade of solid lubricant below 10^{-2}-10^{-5} Pa. Figures 2; references 11 (Russian).
[11-2415]

USSR UDC 539.385:620.184.6:669.721.5

FATIGUE FRACTURE OF CERTAIN MAGNESIUM ALLOYS AT ROOM AND LOW TEMPERATURES IN VACUUM

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 15 No 4, Apr 79 pp 60-63 manuscript received 17 Jul 78

SERDYUK, V. A., GRINBERG, N. M. and OSTAPENKO, I. L., Physico-Technical Institute of Low Temperatures, Academy of Sciences UkrSSR, Khar'kov

[Abstract] A study was made of the fatigue fracture of five magnesium alloys, four of them (MA2-1, MA15, IMV6, MA12) being α-phase solid solutions with a cph crystal lattice on a magnesium base with intermetallic precipitates and one of them (IMV2) a superlight-weight alloy containing a β-phase with a bcc crystal lattice on a lithium base. MA2-1, MA15 and IMV2 alloys have stable precipitates and are not hardenable by heat treatment; MA12 and IMV6 alloys have precipitates which become metastable after heat treatment. Cyclic tension-compression tests at a frequency of 25 Hz were performed at room temperature and at -120°C in a vacuum of $1.33 \cdot 10^{-4}$ Pa. All fatigue curves bend at a point corresponding to the critical stress level which separates the high-amplitude range from the low-amplitude range, this critical stress level being independent of the temperature for the MA alloys and being somewhat higher at the low temperature for the IMV alloys. The life of all alloys is longer and their endurance limit (except that of the MA12 alloy) higher at the low temperature. On the basis of the test data, empirical relations were established between the endurance limit and the static strength. At both temperatures the fracture surface consisted of three zones: stable fracture, accelerated fracture, and static breakoff. This pattern can be explained by changes in the state and the size of the plastic region. Fracture of the IMV alloys at low temperature was characterized by an exceptionally higher degree of ductility. Figures 4; references 8: 6 Russian, 2 Western.

[11-2415]

USSR

CONCERNING FEATURES OF CHANGES IN THE PROPERTIES OF AN AUSTENITIC ALLOY AFTER HEATING AND QUENCHING IN AN ELECTROLYTE

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 4, Jul/Aug 79 pp 56-60

FOMINOV, A. YA. and BORISOVA, G. A., Ryazan'

[Abstract] The anomalous change in the mechanical properties of the 40KNKhMVTYu austenitic alloy during the first 20-30 seconds of electrolytic treatment is related to microstructural changes occurring in the alloy. In the experiment, specimens 104 mm long and 3.84 mm in diameter were heated in an electrolytic solution such as K_2CO_3 (200g/liter H_2O) at 150 or 157 V. As the grain size first decreases, then increases and again decreases, the hardness and the strength as well as the plasticity also change periodically but out of phase with the grain size. A still incomplete analysis of the results indicates that recrystallization during electrolytic heating begins at a low temperature, that the mechanical properties of this alloy, unlike those of the EP52 alloy, change reversibly, and that critical points exist within the range of anomalous behavior. Figures 4; references 5 (Russian).

[1-2415]

THE PROBLEM OF THE COMPLEX UTILIZATION OF THE MINERAL RESOURCES OF KAZAKHSTAN

Moscow PRAVDA in Russian 23 Sep 79 p 2

[Article by Kazakh SSR Academy of Sciences President and USSR Academy of Sciences Corresponding Member A. Kunayev (Alma-Ata): "Integrated Solutions are Essential. Perfecting the Economic Mechanism"]

> [Text] Kazakhstan is known as the land of incalculable treasures. Indeed, colossal natural resources are concentrated here: the republic's underground treasures include one-fifteenth of the world's known mineral reserves. Especially large are deposits of ferrous, nonferrous, and rare metals, coal, and phosphorites. These sources of raw material serve as a reliable basis for the ongoing development of mining, metallurgy, and the chemical industry, machine building, power engineering, and other sectors.
>
> Nevertheless, the time is past when Kazakhstan's mineral riches could be considered inexhaustible. The earth's reserves are large but not unlimited. And the pace of industrial development has become so rapid that some mineral deposits which were thought to be adequate for decades of exploitation are today practically depleted. For this reason, priority importance attaches to comprehensively reducing losses in the extraction of ores and making integrated use of the wealth they contain.

The republic's miners and metallurgists have achieved remarkakble success in this matter, but much slack remains. At the Dzhezkazgan Mining-Metallurgy Combine, one-fifth of the copper ore is left in the ground, and in some places as much as one-third. In one year, the Dzhezkazgan miners lose as much copper as is produced by the Kounrad and Sayak mines taken together. Coal losses in the Karaganda mines are substantial. Only about 10 percent of the casinghead gas is utilized, the rest is flared off. The dumps of the metallurgy enterprises contain many valuable components. Millions of tons of slag, for example, have accumulated near the lead plants; the dumps contain more zinc and lead than the extracted ores. The miners at the Sokolov-Sarbay deposit are extracting only iron, although the ore contains 25 accompanying elements.

In short, the problem of integrated utilization of Kazakhstan's mineral resources is far from being solved. It is not a matter of some kind of mismanagement or lack of foresight. The trouble is that the extraction and processing technologies in use are imperfect and losses are inevitable. What is needed **are different and perhaps fundamentally new techniques. And creating** such techniques and putting them to use will require the combined efforts of specialists in various sectors of science and technology.

Undoubtedly the key role in the integrated exploitation of natural resources is assigned to science. The presidium of the Kazakh SSR Academy of Sciences is focusing considerable attention on problems of technical progress in key sectors of the national economy and helping to raise the work effectiveness of each scientist and scientific collective. The economic effect from the adoption of research findings is rising; last year it exceeded 40 million rubles. Fruitful work is being done in nonferrous metallurgy. This is especially vital, because the nonferrous metal content in the ores is relatively low, extraction technologies are complex and costly, and demand is high.

In the last few years, the institutes of the republic's Academy of Sciences have carried out successful research and passed on valuable recommendations to production workers. They include what is known as the KIVTsET [oxygen-suspended, cyclone, electrothermal] technology of processing copper-zinc ores, the smelting of copper-nickel concentrates in a liquid bath. Promising ways of making integrated use of aluminum ore containing titanium are also being studied.

Important research is being conducted in other directions relating to fuller and more efficient exploitation of mineral resources. One might cite experiments in molecular biology and the genetics of plant and animal microorganisms, research into techniques of directed synthesis of physiologically active substances, and improved techniques of processing phosphate ore for fertilizers and feed additives, promising a substantial increase in field and stock farm productivity. A vast program has been mapped out in connection with the problem of transferring some of the water from Siberian rivers to Kazakhstan and Central Asia. It is necessary to evaluate the soils in terms of their suitability for irrigation, to draw up reclamation forecasts, and to determine the possible environmental consequences of carrying out such a huge project.

Practical experience indicates that the greatest effect is achieved where the quest is conducted in an integrated manner, where production workers as well as scientists work hand in hand. We see the development and consolidation of such contacts as the main thrust in the successful resolution of complex problems relating to the thrifty utilization of natural resources. Accomplishments have already been made. In particular, integrated scientific-technical programs have proved highly effective. One of them was worked out by the republic's Academy of Sciences and the Ministry of Chemical Industry and includes 28 themes, involving the participation of four of our institutes and nine all-union associations. The results have been encouraging and indicate that this kind of collaboration is effective and mutually beneficial. The traditional friendship of the scientists and the collectives of the nonferrous metallurgy enterprises has borne fruit. Unfortunately, relations between the academic institutes and the republic's ministries leave much to be desired.

Recently, a new form of link-up between science and production came into being--sector laboratories included within the structure of the academic institutions but financed by the departments. They make it possible to convert from occasional economic contracts to long-term alliances in investigating and adopting prospective technological processes. One such laboratory, set up within the Mining Institute, has begun to investigate techniques of processing ferrous metal ores in Kazakhstan's enterprises. Several other laboratories are to be organized to deal with different sectors. Unfortunately, the relevant ministries are dragging their feet, pleading lack of funds.

The most serious obstacles arise in putting to work the fruits of scientific applications worked out at the interface of different sectors. One example is a technology, recommended for adoption 10 years ago, for obtaining new glass-crystal materials--slag pyroceramics--from phosphorus-containing slags. It has been determined that the necessary capital outlays can be recouped in two or three years. The advisability of setting up such an operation in Kazakhstan was recognized by the republic's Council of Ministers and Gosstroy in the last five-year plan. To this day, however, it has not been decided who is to finance the project-planning and construction of the pyroceramics shop. Yet the task is an easy one to solve--all it takes is to get the relevant ministries involved on a share basis.

The rapid development of the republic's productive forces requires the scientists' active participation in planning. It should not be necessary to prove that ill-considered decisions made without comprehensive scientific substantiation can not only cause a chain reaction of excessive outlays but also lead to serious disruptions in the economic mechanism and have undesirable social consequences. Unfortunately, there are many examples of this kind. It sometimes takes years to bring newly-built enterprises up to projected capacity because when they were built no account was taken of important environmental factors and serious errors were made in evaluating local resources. Our specialists would willingly get involved in the discussion of problems arising in connection with the exploitation of mineral deposits, the planning of settlements, and the location of facilities--in short, in any case where scientifically substantiated advice is essential. Frequently, however, the planning bodies prefer to make do with their own personnel, which are sometimes clearly inadequate. Hence the frequent errors and oversights.

For example, in the construction of the Irtysh-Karaganda Canal, problems of the rational use of water, the construction of new sovkhozes, and integrated development of riverside land sections were left in the background. To this day the huge Kapchagay Reservoir has not produced the anticipated yield, although more than 10 years have passed since it was built. If the competent opinions of the specialists had been heeded at the time, many such difficulties would never have arisen.

Obviously, it is time to set up a single coordinating organ in the republic to take care of the integrated development and rational utilization of natural resources on a strictly scientific basis and seek out optimal solutions. In its efforts such a body would draw on interdepartmental commissions and scientific councils dealing with specific problems. Of course such a body would have to have the necessary powers. Perhaps the Kazakh SSR Council of Ministers State Committee for Science and Technology should be revived, perhaps the republic Gosplan's science division should be beefed up. There are other possible solutions. One thing is clear: departmental dispersion and the all too frequent **ignoring of scientists' recommendations are not doing any good.**

The CPSU CC and USSR Council of Ministers decree "Improving the Planning and Strengthening the Influence of the Economic Mechanism on Raising Production Effectiveness and Work Quality" stipulates that the ministries and departments of the USSR and the councils of ministers of the union republics are to approve plans for raising the technical level of the sectors as well as plans of environmental protection. Scientific substantiation of these plans requires a precise procedure stipulating obligatory examination, by the ministries and departments, of the proposals of scientific institutions, as well as responsibility for making the appropriate decisions.

Kazakhstan's scientists are doing considerable systematic and purposeful research. This is strengthening ties between science and production, whose end goals coincide. For this reason, it is essential to improve conditions for their constant and creative interaction.

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BRIEFS

BERELEKH MINING COMBINE--Miners of the Berelekh combine prepared well for the gold mining season. The Maldyak placer mine fulfilled its annual plan on 20 September and 3 days later the Burkandya placer mine fulfilled its plan. Today these mines are continuing to extract gold. [Text] [Magadan Domestic Service in Russian 0755 GMT 2 Oct 79]

DALNIY PLACER MINE--The Dalniy placer mine of the Bilibino mining and concentrating combine fulfilled its annual gold extraction plan and pledges yesterday. [Text] [Magadan Domestic Service in Russian 0755 GMT 2 Oct 79]

PANWASHING ARTEL--The Razvedchik panwashing artel of the Kurchatovskiy placer mine has reported fulfillment of its annual gold extraction plan and the plan for the first 4 years of the 5-year plan for gold extraction. [Text] Magadan domestic service in Russian 0755 GMT 5 Oct 79]

KERBI PLACER MINE--The Kerbi placer mine, which has started this year considerably behind its plan, has improved its work and has fulfilled its annual metal extraction plan. [Text] [Khabarovsk Domestic Service in Russian 0930 GMT 10 Oct 79]

CSO: 1842-F

Nonferrous Metallurgy

METALLURGY FOR AVIATION AND SPACE

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 79 pp 44-45

[Article by P. Lomako, Minister of Nonferrous Metallurgy of the USSR, Hero of Socialist Labor]

[Text] Nonferrous metallurgy has covered a great and glorious path during the years of Soviet power. Large industrial enterprises supplied with modern equipment, which produce 74 of the 107 elements of the periodic table, have increased. The output of aluminum, nickel, cobalt, magnesium, titanium, tungsten, molybdenum, hard alloys and refractory metals has increased sharply. Powder plants and powder metallurgy are being developed. Significant qualitative and quantitative changes have also occurred in treatment of nonferrous metals.

Aluminum has long been called the winged metal. Its production was begun during the years of the First Five-Year Plan when the Volkhov, now the Order of the October Revolution Aluminum Plant became operational. The Dneprovsk, Ural, Nadvoitsy, Sumgait and other plants were later constructed for aluminum production and the Kol'chugino Plant imeni S. Ordzhonikidze, the country's first to organize duralumin production, which was named "Kol'chugaluminum," was reconstructed. It was from this alloy that all-metal aircraft were manufactured--the first ANT and later--jet "IL's," "Yak's," "MIGs," "LA'S," "TU's" and other winged craft.

As aviation developed, nonferrous metal production required scientific research and scientific management. Scientific research centers were organized in the country--the All-Union Aluminum-Magnesium Institute and the All-Union Institute of Aviation Materials, which together which together with the metallurgical plants began to develop new high-strength structural aluminum alloys.

It is now difficult to find a sector of the national economy in which aluminum and its alloys are not used. Their role in aviation and missile technology is especially great: up to 80 percent of the weight of structures in a modern aircraft consists of alloys of light metals, including aluminum metals.

During his trip to Siberia and the Far East, Comrade L. I. Brezhnev posed specific tasks on further development of the aluminum industry. Giving a talk to the bureau members of the Irkutsk CPSU obkom in April 1978, he emphasized that development of aluminum production, especially in the eastern part of the country, is included among the most important tasks.

During the past few years another "winged" metal--titanium--was acquired ever greater significance, especially in supersonic aviation. It has attracted the attention of scientists and investigators as a promising structural material with regard to the vigorous progress of jet aviation. The fact is that aerodynamic heating (up to 250°C and above) occurs with an increase of flight speed (more than 2,700-2,800 km/hr). Aluminum and magnesium alloys of it do not tolerate these conditions: they become soft, lose their strength and become unsuitable for the skin of supersonic aircraft. Titanium and its alloys must then replace aluminum.

The level of titanium use in aircraft designs will also be increased as flight speeds and aircraft size increase. Whereas its amount in subsonic aircraft comprises 1-3 percent of the total weight of the machines, its amount goes from 3 to 10 percent in aircraft flying at speeds up to 2,400 km/hr. And the amount of titanium reaches 95 percent in aircraft flying at higher speeds, that is, only those parts in which metals are generally not used are not manufactured from it.

Titanium is now entering the first 10 of the most widespread elements of our planet. Its content in the 15-kilometer mass of the earth's crust exceeds half of 1 percent; it is contained in almost all crystalline rock, sands, clays and similar constituents of the earth's crust in a dioxide rather than in pure form.

The first industrial titanium in our country was produced at the Podol'sk Chemical and Metallurgical Plant. Extensive efforts of investigators, engineers, designers and workers were required for successful development of the industrial method of its manufacture. Data obtained at the Podol'sk Chemical and Metallurgical Plant were the basis for designing the firstborn of the titanium industry--the Dneprovsk Magnesium Plant, which has now been converted to the Zaporozh'ye Titanium-Magnesium Combine (ZTMK), the main production of which is cellular titanium.

Development of the magnesium industry contributed to a significant degree to the birth and development of industrial titanium production. The magnesium-thermal method of producing titanium determined the fusion of these two types of production into a unified industry. The Berezniky Titanium-Magnesium Combine became operational in 1960 and the Ust'-Kamenogorsk Combine became operational in 1966. The latter, constructed from a design of the Giredmet Institute [State Scientific Research and Planning Institute of the Rare Metals Industry] is the most technically perfected enterprise of the country with high degree of mechanization and automation of production processes. The State Badge of Quality has been awarded to the higher grades of cellular titanium.

Moreover, production capacities have also been created in our country for smelting titanium ingots and alloys and in treatment of them under pressure on scales which completely meet the needs of the aviation, shipbuilding, chemical and metallurgical industries and other sectors of the national economy.

Soviet titanium is exported to many foreign countries: to the governments included in CEMA and also to the United States, Great Britain, France, West Germany, Italy, Sweden and others. It competes successfully with the best grades of this metal produced by American, English and Japanese companies.

The high rates of development of aviation and space technology are already forcing a search for new materials. Alloys based on zirconium, niobium, tantalum, tungsten and molybdenum are coming to the aid of aluminum and titanium. Even small quantities of refractory metals introduced into alloys based on iron and nickel significantly increase the temperature limit of their operation and permit the use of the obtained materials for manufacture of disks and vanes of jet engines. Refractory metals generally have no competitors at temperatures of 1,200-2,500°C and are used, for example, in thermionic energy converters in spacecraft,in thermoelectronic converters and also in manufacture of high-temperature antennas.

The use of refractory metals ensured the development of investigations on design of supersonic aircraft. The operating characteristics of rocket engines could be improved significantly due to the use of tungsten. The operating temperatures of rocket nozzles increased above 3,000°C. The use of gas and aerodynamic controls manufactured from tungsten and molybdenum contributes to an increase of the operating dependability of control elements.

Alloys based on rare refractory metals have a number of unique physical properties. For example, rhenium alloys are irreplaceable wherever the thinnest, but superstrong wire is needed. Filaments of them 2-3 times smaller than the thickness of a human hair will support a load of more than 7 kilograms. Torsion bars and tension members from molybdenum alloy with 50 percent rhenium provide high accuracy and reliability of gyroscopic devices. Rhenium electrocontacts are indispensable in automatic electronic relays operating under vibration and corrosion conditions.

Modern aircraft, spacecraft and industrial objects would be impossible to imagine without computers, electronic and modern monitoring-measuring apparatus. The development and production of electronic materials based on germanium, selenium, tellurium, cadmium and indium contributed to development of on-board electronic and computer equipment and provided the development of unmanned spacecraft equipment. The most suitable material for manufacture of aircraft semiconductor displays during the past few years is a gallium-arsenic-phosphorus compound.

The noble metals are finding new application. The most crucial parts of rockets, artificial earth satellites and aircraft are covered with gold.

Helmet visors coated with a thin layer of gold admit light and reflect infrared rays. Alloys containing gold are used in microelectronics and in precision instrument building.

Silver is used in high-frequency equipment, aviation resistance thermometers, drinking water for cosmonauts, in space photography, solar cells and many other areas. Palladium and tungsten alloys increase the reliability and length of continuous operation of many electronic devices by a factor of 20. Iridium is used in especially crucial electric contacts. Its alloy with osmium is used to manufacture the supports of the most precise devices.

Materials of both inorganic and organic origin, which have superior strength and anticorrosion properties, are finding ever greater use along with metals. Also promising is the improvement of the properties of metals due to particles of refractory compounds--dispersion inclusions. Dispersion strengthening of materials by aluminum, beryllium, iron, tungsten, niobium, titanium, zirconium, magnesium and other oxides, carbides and nitrides increases heat resistance to a significant degree and improves their other properties.

The rapidly growing family of composite materials includes cermets, foam metals and also various metals, alloys and minerals reinforced with fibers and wire. The strength of refractory metals reinforced with sapphire or graphite "whiskers" is increased sharply. Foam aluminum, which is five times lighter than water, but retains the strength of cast metal, is already being used in aviation and rocket construction. Aluminum reinforced with boron fibers exceeds the best of its alloys in strength and stiffness by a factor of 2-3. Spar straps, the blades of helicopter rotors and the skin elements of aircraft are manufactured from it. Composites based on magnesium, titanium, beryllium and other metals and minerals are being developed.

Composites of high modular carbon fibers and carbon matrix have high specific strength under pulse and constant loads up to 1,500°C and above. They exceed all the presently known light structural materials in heat resistance.

The use of carbon-carbon composites in modern aircraft reduces their weight and improves their flight characteristics. Controls, stabilizers, air brakes, the horizontal fairing, engine parts and the blades of helicopter rotors are manufactured from composites based on an organic matrix.

Composite and ceramic materials provided by domestic nonferrous metallurgy are used in the heat shield components of missiles and spacecraft and contribute to reliability and flight safety in engines. A significant increase of the output of aviation engines is promised by the use of ceramic turbine blades.

Magnets which are capable of lifting a load which exceeds the weight of the magnet itself 500 times are now beginning to be produced by powder metallurgy methods from alloys of cobalt and rare earth elements--samarium, prasecdymium or cerium. Their energy exceeds the similar characteristics of magnets manufactured from steel, nickel, cobalt, aluminum and copper alloys and also platinum and cobalt alloys tens and hundreds of times.

Magnets of cobalt with rare earth elements are becoming the basis for developing supportless bearings in gyroscopes--the main instrument of aircraft. They are also used in small engines with especially rigid characteristics used for satellite stabilization systems.

Specialists are placing high hopes on production of materials with the most valuable properties in space. The main factors of space flight useful for accomplishing metallurgical processes are a vacuum and reduced gravity. Under these conditions it is possible to develop composite and superconducting materials with homogeneous phase distribution during crystallization of a melt containing a suspension of insoluble particles. Smelting of eutectic alloys with ordered distribution of needle components or with a fiber structure is also possible. Experiments on welding heterogeneous materials are also of interest.

Space production of semiconductor materials opens up many opportunities. The manufacture of single crystals, semiconductor materials with high homogeneity of composition, given shape and with dimensions not achievable on earth is possible in a space vacuum. Production of these materials is the basis for development of essentially new and unique devices.

The enterprises of nonferrous metallurgy are now producing superpure metals in which a content of no more than one atom of impurity per billion atoms of base material is permitted. Even pure materials will be produced in the vacuum of space.

Development of space metallurgy will permit reevaluation of presently used processes for production of nonferrous metals, alloys and materials from them and will make significant changes in the earth technology of producing them.

The Communist Party and the Soviet Government regard nonferrous metallurgy as the basis of scientific and technical progress of the country and constantly devote important attention to development of this sector of industry. It is planned to increase the production of aluminum, copper, nickel and titanium during the 10th Five-Year Plan. The output of alloying, rare and precious metals, secondary nonferrous metals, especially pure semiconductor and special materials and diamond production are being expanded significantly.

By increasing the production of these materials and expanding the area of their use, the nonferrous metallurgy of the USSR is thus fulfilling the task posed by the 25th CPSU Congress "development and extensive introduction of an essentially new technology, new design, magnet, semiconducting, superconducting and other materials and technically valuable crystals."

Seventeen collectives of nonferrous metallurgy enterprises, including 13 entered on the All-Union board of honor of VDNKh of the USSR, were recognized as the winners and were awarded the challenge Red Banners of the CPSU Central Committee, the USSR Council of Ministers, the VTsSPS and the VLKSM Central

Committee for achieving the highest results in the All-Union socialist competition to increase production efficiency and the quality of work in 1978, providing stable indicators and fulfilling plans and increased pledges.

In 1979 the collectives of the nonferrous metallurgy enterprises, having adopted increased socialist pledges, are competing for successful fulfillment of them and are full of resolve to provide the motherland with greater production of high quality.

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MINISTER OF NONFERROUS METALLURGY DISCUSSES SCIENTIFIC PROGRAM

Kiev RABOCHAYA GAZETA in Russian No 214, 18 Sep 79 p 2

[Article by USSR Minister of Nonferrous Metallurgy P. Lomako: "Branch Scientific Program"]

> [Text] This five-year plan, laborers in the country's nonferrous metallurgy are increasing production volume, expanding assortments, and improving output quality. This process is inseparable from continuous retooling, the introduction of progressive equipment and technology, and use of the achievements of science. A close cooperation with organizations of the USSR and union republic academies of sciences and with scientific institutions of the higher school has developed in the branch. Enterprises maintain ties with more than 70 institutes in various specialties. Such forces are up to solving complex scientific and technical problems.

Long-standing creative contacts have been set up with the Ukrainian SSR Academy of Sciences, the foundations for them having been laid by Academician V. I. Vernadskiy, who did much to establish and develop domestic nonferrous metallurgy. In recent years, the ties of the individual institutes and enterprises have grown into creative cooperation by the entire branch with the Ukrainian SSR Academy of Sciences, the organizational basis of which has become the joint plan of scientific research work approved by the collegium of the USSR Ministry of Nonferrous Metallurgy and the Presidium of the Ukrainian SSR Academy of Sciences. It outlines 24 topics with an anticipated economic impact of 30 million rubles.

We can note with satisfaction today that 10 academy institutes of the republic, jointly with institutes and enterprises or our branch, are carrying out this program successfully. Research is being done on a broad range of pressing problems of nonferrous metallurgy development. They include the development of complex technology for refining lead in molten electrolytes, obtaining bismuth in ion melts, powder metallurgy, copper extraction, electroslag welding, dynamic hot-stamping of porous materials and tungsten-free alloys, detonation welding of metals and alloys, and many others.

Using a development of the Institute of Electric Welding imeni Ye. O. Paton, the Sverdlovsk plant for working nonferrous metals and alloys by detonation has mastered technology for obtaining bimetals. The Ukrainian SSR Academy of Sciences' Institute of General and Inorganic Chemistry has created technology and apparatus for cathode lead refining in hydroxide melts at the Elektrotsink plant in Ordzhonikidze and a new two-layer electrolyte for obtaining bismuth in ion melts has been introduced at the Dal'polimetall association.

The Titanium Institute of the Ukrainian SSR Academy of Sciences and the OKTB [public technological-design bureau] of the Institute of Problems of Materials Science have reviewed the substantiation of principles for obtaining powdered titanium by primary electrolysis. They have perfected processes for refining titanium and producing new products on the basis of those processes. The economic impact of this work in the current five-year plan alone has been about two million rubles.

Joint efforts by the Almalyk Mining and Metallurgical Combine and the Ukrainian SSR Academy of Sciences' Institute of Organic Chemistry have resulted in a new extractant and initial data have been prepared for building an industrial facility. Also here, with the assistance of the Ukrainian SSR Academy of Sciences' Institute of Cybernetics, a system of planning and operational management of mining transport work using computer equipment has been put into operation.

These examples should provide an idea of the broad programs of influence the Ukrainian SSR Academy of Sciences institutes have on technical progress in the branch. The results of this cooperation are regularly and bilaterally reviewed and evaluated. This past summer, a joint meeting of the presidium of the Ukrainian SSR Academy of Sciences and the collegium of the USSR Ministry of Nonferrous Metallurgy was held in Kiev. It approved a five-year plan of scientific research and experimental design work.

This plan is an important step forward towards broadening and deepening our cooperation. It anticipates work on 64 topics, nearly three times as many as in the current five-year plan. It reflects the development and introduction of the very latest progressive technological processes and machines. The new plan also covers such fields as labor and environmental protection. We have every reason to think that this extensive program will be carried out in full.

Nonferrous metallurgy is one of the most complex branches of the national economy. Its specifics lie in the necessity of extracting and processing enormous amounts of ore of the most diverse composition. The technology for using such raw material comprehensively and as fully as possible anticipates the use of a large number of complex physical, physico-chemical and physico-mechanical processes. Under these conditions, resolution of the tasks set by the 25th CPSU Congress of accelerating scientific and technical progress in the branch will depend largely on prompt fundamental research as the basis for developing modern technologies, machines and units. That means further, significant expansion of cooperation among scientific collectives will be required.

What, in your view, are the pivotal, key directions in which nonferrous metallurgy needs the serious assistance of the fundamental sciences?

The list of tasks is quite broad. It encompasses geology, all the subdivisions of mining, enriching and metallurgical production, metal and alloy working, environmental protection, economics, as well as methods of precise technical control of production.

One of the most critical problems is providing nonferrous metallurgy with a reliable raw material base. This applies first of all to copper, aluminum, tungsten-molybdenum, tin and lead-zinc industry. It is extremely important that we have data from geological forecasting of deposits, new methods of surveying, prospecting for and selecting the most efficient systems of extraction, especially at great depths. We also need fundamental research on controlling mining pressure to prevent mining shocks when digging ore at great depths. New methods of breaking up rock and flow-line technological processes for open-pit mining must be created. Miners are waiting for well-made self-propelled subsurface machinery complexes.

In connection with the necessity of mining and processing enormous quantities of rock and ore, the problem arises of creating fundamentally new processes and machinery for crushing rock (drilling, crushing, pulverizing), and of industrial technology and techniques for assaying and grading ore during prospecting, mining, transporting and enrichment. Nuclear physics and radiometric methods of analysis and automatic grading will be used. These tasks rest in part on the shoulders of the institutes of nonferrous metallurgy. The Physico-chemical Institute, Institute of Problems of Materials Science, and the institutes of fluid mechanics and geotechnical mechanics of the Ukrainian SSR Academy of Sciences are linked.

Now to another item on the agenda -- lean ores. Their enrichment must be radically improved, new flotation reagents must be developed, the bonds between organic compound structure and flotation properties must be studied, and economical methods of extracting metals directly from ore right at the deposits must be developed.

In recent years, nonferrous metallurgy has emerged as a branch producing new materials with special, unique properties. They include complex semiconductor compounds and composite alloys. In order to develop their production, we need a profound theoretical base which will permit us to predict with confidence the properties of materials as a function of their composition, physico-chemical state and structure. We are in need of theoretical principles for obtaining monocrystals with an even distribution and the prescribed number and type of dislocations. We cannot get by without a theory of the growth of crystals from fusion and gas phase. In resolving these tasks, there already is experience in fruitful cooperation between the State

Institute of Rare Metals and Scientific Research Institute of Graphite and the institutes of semiconductors, nuclear research, physics and problems of materials science of the Ukrainian SSR Academy of Sciences.

We need the accelerated development of domestic equipment and processes for obtaining copper electrolytic foil, copper and copper alloy powder with prescribed properties. The way to do this is to do serious work in the field of metals science, metalworking, welding, and developing means of control and automation.

And one more thing. Each year, metallurgical enterprises discharge large amounts of sulfur dioxide, hydrogen fluoride, arsenic, lead and other toxic substances along with their exhausts. We must find cheap, effective methods of cleaning and utilizing sulfur gases and industrial discharges. Environmental protection installation designs have thus far been expensive to build and often inadequately reliable.

Problems of using raw material resources comprehensively are closely tied to environmental protection problems. A majority of our branch institutes are concerned with them. The 1981-1985 plan of cooperation anticipates participation in this by Ukrainian SSR Academy of Sciences institutes -- that of electric welding imeni Ye. O. Paton, the gas institute, and the institute of general and inorganic chemistry. In reference to work on protecting the environment and using raw material resources comprehensively, we must not fail to note that the development of technology for involving enrichment plant "tailings" and metallurgical slag in construction materials after nonferrous metals have been extracted from them is of most important significance to the national economy.

The scientific and technical problems facing nonferrous metallurgy can be solved and fundamentally new and more economical processes and technological designs can be developed only by relying on the modern achievements of physics, chemistry, electronics, cybernetics, biology.... And the Ukrainian SSR Academy of Sciences has the ability to do this.

The above does not exhaust all the problems of nonferrous metallurgy, only a small portion of them. I should hope that the above-mentioned urgent tasks of developing the branch will be taken into account in the future development of our cooperation and in drawing up plans for joint work by institutes of the Ukrainian SSR Academy of Sciences and scientific institutions and enterprises of the USSR Ministry of Nonferrous Metallurgy.

In its decree "On Improving Planning and Intensifying the Influence of the Economic Mechanism on Improving Production Efficiency and Work Quality," the USSR Council of Ministers and [illegible] Central Committee demanded the development and submission to the [illegible] plan of programs for solving the most important scientific and technical problems and problems of the comprehensive use of natural resources with consideration of applying the results of fundamental and applied research and that they indicate final goals, technical and economic results, and the schedules and stages in which the work is to be carried out. The cooperation between enterprises and scientific institutions of the USSR Ministry of Nonferrous Metallurgy and institute of the Ukrainian SSR Academy of Sciences corresponds fully to the spirit of this most important document.

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DIRECTOR OF POWDER METALLURGY INSTITUTE DISCUSSES ACTIVITIES

Minsk KOMMUNIST BELORUSSII in Russian No 8, Aug 79 pp 65-72

[Interview with O. V. Roman, Director of the Scientific Research Institute of Powder Metallurgy, conducted by V. Khotyanovskiy]

[Text] In the decisions of the XXV session of the Party, the decrees of the Central Committee of the Communist Party of the Soviet Union "On Further Improvement of the Ideological and Political-educational Work," the problem of combining the advantages of socialism with the achievements of the scientific and technical revolution is called historical. This program position reflects the spirit of our era, the directed nature of a mature socialist society to bring the newest achievements of science and technology to the service of the people.

In our country, science has become a powerful production force. It has, figuratively speaking, put on its working clothes. However, there can be no model in the solution of this problem. A persistent, constant search is required. It is not coincidental that any positive experience in bringing scientific research closer to the requirements of production and labor collectives arouses constant interest.

By right, the winner of the All-Union Socialist Competition for the year 1978 in the Minvuz's [Ministry of Higher, Secondary Specialized and Vocational Education] is one of the foremost scientific collectives in the country today. This group is the Scientific Research Institute of Powder Metallurgy (NIIPM), a part of the Belorussian Polytechnical Institute (BPI).

We publish below a transcript of the conversation between a contributor to our magazine and the director of the NIIPM, the honored scientist and technologist of the Belorussian SSR, O. V. Roman.

[Question] Oleg Vladislavovich, we would like for you to tell our readers about the formula "Consistently to solve the problem of an organic union of the achievements of the scientific and technological revolution with the advantages of the socialist economic system," which is being advanced by the party in the everyday affairs of your institute.

[Answer] I will try. But first a few words about the significance of that scientific problem which occupies the institute. Powder metallurgy is now in the rapids of scientific-technological progress for two reasons. The first is that its methods permit us to create materials with specific properties which cannot be produced by other methods, particularly the super-pure and the super-hard, the porous and the fibrous, the frictional and the anti-frictional, etc., etc. This list is lengthy. The second reason is the significant savings in metal and the growth in productivity due to almost total elimination of mechanical processing: there is a possibility for producing parts and castings with high precision immediately.

Powder metallurgy is now experiencing a second birth since the successes of machine-building, physics and chemistry have resulted in an intensification of the process for producing metal powders. It is more useful to pulverize the liquid metal and then mold a ready part from the powder which is produced than it is to cast it. Casting understandably is cheaper, it is true, but, in the first place, founding is by no means always accurate and the following treatment "eats up" the gain in the cost of the part. In the second place, using pulverized metal permits us to produce a material having a fine-grain structure and high quality. All of these taken together predetermine the great attention which is now devoted to the development of powder metallurgy, an approach capable of solving problems having great significance for the most diverse areas of the national economy, from the kolkhoz field to the cosmos. In other words, powder metallurgy is a typical inter-industry scientific-technical direction.

[Question] Tell us, how is powder metallurgy developing in other countries?

[Answer] Very intensely. However, there is a significant circumstance which has permitted our country to reach significantly higher rates of development in this industry than any of the western countries. This condition is the possibility of cooperation, of uniting the efforts of production enterprises and scientific institutions of various departments. If one takes as an example such large U. S. firms as General Motors, General Electric, they, conducting their own research in this area, carefully keep it secret, keep it from competitors within their own country.

Here, we have matters set on a state, on a planned basis. The USSR's State Committee on Science and Technology is now realizing and is planning a concrete program for the development of powder metallurgy for the eleventh five-year plan. The efforts of a number of ministries, institutes, enterprises etc. are being united for its fulfillment.

[Question] And now let's cross the "bridge" from common problems and advantages directly to those matters with which the Institute's collective is occupied. Tell us, if you please, about the basic directions of your work.

[Answer] The first direction is material casting. I'll try to explain what the complications are here. A free-flowing body, the metal powder, is our initial material. It is necessary to impart the necessary form to this material. The closer this form is to a finished item, the less the expenses for subsequent processing will be. To do this, it is possible to use various methods. Let's say that we will pour the powder into a mold having high thermal strength, heat it and produce a finished item by diffusion processes. Porous parts are most frequently done in this manner. However, casting in rigid press molds is more widespread. Here specific complexities arise and their solution requires in-depth research work. That is what we do. The next stage is comprised of the design operations associated with the mechanization and automation of the industrial technology of compression-molding items from powders. This is very complicated since pressures on the order of 6,000 atmospheres and sometimes greater are necessary. I will explain for further clarity: in order to produce a part the size of a normal book from powder, a press with a force of no less than 2,000 tons is necessary.

I have already said that powder metallurgy permits us to produce items with high accuracy and strength. It is here that cold and hot forging methods are required. An investigation of these processes as applicable to powder materials occupies a large part of the total volume of the Institute's work. Even this fact shows their significance. Parts for several actual instruments are being made by traditional methods: by cutting them from all-metal blanks. The coefficient of metal use in this case is equal to 0.3-0.35. And when these same parts are fabricated using our methods, this coefficient rises to 0.95-0.98, an extremely perceptible difference.

Now we are working to create the first automatic line in the world for mass fabrication of similar parts. Of course, not alone. Creation of the lines is a large program. More than ten large enterprises and institutes helping to solve problems of mechanization, automation and the creation of control systems, etc. are participating in its realization. At the same time, we are studying the possibility of creating parts of more complex molds from the most diverse materials using the same methods.

The next direction is friction materials for work under conditions which existing articles cannot withstand at present. Let us say that for the hydraulic transmissions for heavy trucks, for equipment working in potash and other mines, we need a material capable of working for a long time at temperatures from -50 to +80 degrees and which would at the same time have a high friction coefficient, show little wear and possess other merits.

We have succeeded in creating such materials. Moreover, in our experimental production we produce more than 50,000 friction clutch discs which go for highway machinery, automobiles and even for electronic computers.

It's true that the area for using the porous materials which are being created here is unlimited. They may function both in outer space and on earth. I have in mind heat pipes, as they are sometimes called, superconductors of heat, filters for various purposes. They are already in use for purifying fuel and metallurgical electrolytes, harmful industrial effluents and milk. The problem is to create the production methods for making porous materials of preassigned density. Additionally, similar metals as a rule should be corrosion-resistant. Therefore, rather expensive powders, particularly titanium, have been used for making them up to this time. We have posed the problem of converting to aluminum, which protects itself from corrosion with an oxide film. However this very oxide hinders press-molding of articles. We have to overcome this barrier. Everything mentioned requires much investigative work. It is already under way and the first successes are at hand.

By the way, work with the filters produced a curious "offshoot," the creation of molds from porous materials. This is a very interesting and promising matter.

Our institute is the leading organization for the use of explosive energy for press molding metal powders and producing various composition materials in the country. The peaceful explosion has received wide distribution here. The initiative for its use belongs to the most prominent Soviet scientist, Academician M. A. Lavrent'yev.

Finally, the newest direction, which was conceived here about two years ago, is the creation of protective gaso-thermal coatings. We were much inspired by the fact that the president of the USSR Academy of Sciences, A. P. Aleksandrov, in a speech on the anniversary of the Academy of Sciences, Belorussian SSR, in Minsk in May of this year gave a high evaluation of these efforts.

[Question] Until now, we have spoken with you about the research side of the Institute's activity, about that great work which has been done to accumulate knowledge of the essence of new physical and chemical phenomena and technological processes. Together with this, as comrade P. M. Masherov, first secretary of the Central Committee of the Belorussian Communist Party and candidate for membership in the Politbureau of the Central Committee of the Communist Party of the Soviet Union emphasized at the republic meeting of the active Party membership which was held recently, the "development of the skill to deal efficiently with the growing volume of knowledge, the capability for translating it into living practice and thereby enriching it" is now acquiring exceptional importance. Let us look at the matter from this side.

[Answer] We have posed this type of problem literally from the first days of our establishment's existence. Having decided to create a laboratory, we studied the requests of industry and understood the following: powder metallurgy is a field with a great future. Then the Belorussian Polytechnical Institute's Powder Metallurgy Laboratory was created, and not at the

Institute, but at the "Udarnik" plant. We began to develop the production techniques and then to make parts for the machinery at this enterprise. By the way, these contacts are still maintained today; our experimental production supplies friction clutch discs for "Udarnik." Then our laboratory came to be called a "basic laboratory," and, since 1962, an "industry laboratory." But this framework was restrictive. To be locked into a circle of purely utilitarian problems would mean to lose the novelty, the spirit of creativity. It was necessary to prove one's right to be engaged in not only that which was necessary for the plants today, but in science as well, in development of fundamental theoretical questions. There was one path to this position, again, a practical affair, the creation of the powder metallurgy section at the Minsk gearwheel plant. In 1964 the laboratory became a problem-solving laboratory. Of course it did not lose its connections with practice; in any case, the first thousands of parts for the MTZ [Minsk Tractor Plant) and several other plants were fabricated in the Laboratory's experimental production.

However, it soon became clear that the volume of work of which the laboratory was capable could not satisfy the demands of the republic. And then, due to the assistance of the Central Committee of the Belorussian Communist Party and the republic's Council of Ministers, the Laboratory was converted into a Scientific Research Institute in 1962. Industry alloted us the means to create an appropriate base. In a word, the scope of our search expanded significantly and new possibilities for the solution of complex problems appeared.

[Question] It comes to mind that about three years ago you said approximately this: "We have learned to do much, but often we do not know who needs it." How is it now?

[Answer] That was true then, although even by 1975 we had produced a savings in the sum of about R1.5 million. Much has changed since then. The Institute has grown, experimental production has increased and the Special Design Bureau was set up. All questions concerning incorporation have been transferred to this bureau. This permits us to use the creative potential of our scientific associates more effectively. In 1978, the yield from our developments increased threefold, approaching R4.5 million. About R2.4 million was produced from their use at 22 enterprises in the Belorussian SSR. Powder metallurgy sections created with our assistance are in operation at 6 plants, in Minsk, Brest, Nesvizh and Zhodino.

Nevertheless, at the plenum of the Central Committee of the Belorussian Communist Party which met in December, 1978, they properly addressed the fact that the possibilities of powder metallurgy and the existing scientific-technical potential in this area are still being exploited inadequately in the republic.

A number of important questions for the future were solved with the direct participation and the considerable assistance of the Central Committee of the Belorussian Communist Party, the government and the republic's Gosplan, in particular, measures have been applied for further strengthening the scientific and experiment-and-testing base of the NIIPM. Construction on a modern test site for conducting experimental work in explosive technology will begin in 1981. The Institute will obtain two new wings in 1983. In the same year, the first phase of a pilot plant which will produce 5 and then 10 thousand tons of items annually should begin work. For comparison, I will say that now 650 tons of articles are produced from metal powders yearly within the republic.

[Question] Strengthening the material and technical base of the Institute and creating the pilot plant are important matters proceeding from the resolutions of the XXV session of the Communist Party of the Soviet Union. But there is still a second side of the question--the introduction of finished developments.

[Answer] It is clear that the high tempi for the development of production require not only research and the creation of laboratory models or prototypes from the workers of science. A developed industrial technology, a system for organizing the broad application of the results of scientific research, is needed.

There is such a system. There are academic institutes which are working on fundamental problems, determining the basic principles for their application in engineering and technology. There are also industry institutes which have been called upon to bring these principles to experimental-industrial applications. However this system does not function for a number of inter-industrial trends, particularly powder metallurgy.

[Question] Why?

[Answer] In the first place, the volume of work in the area of powder metallurgy is as yet relatively small. In the second place, the problem itself is complex. More and more new research in the area of engineering and technology is required for its solution. In the third place, it is difficult to transfer ready operations to the industry institutes: they are all in "foreign" departments.

[Question] Three years ago you said that it would be possible that in the future the Institute might follow such a course: to select a mass part at some plant, master its fabrication from powders in its experimental production and undertake its delivery for the whole program in the course of, let us say, two years. During this period the plant must acquire the necessary equipment, instruct its people at the NIIPM and master production of this part. And the Institute will undertake the study of another problem. Have you rejected this idea?

[Answer] No, we have simply ceased considering it to be the only successful way. The process about which I spoke is already in use. Thus we produce the bearing races for one type of bearing and we are teaching the new production techniques to plant cadres. The plant is now acquiring the equipment. When a "production" section is set up there, we will transfer the production techniques which we have developed, and we will stop making the rings.

But there are other variants to this solution. Let us say that we have started to collaborate with the Baranovichskiy Automated Unit-production Plant of the "BelavtoMAZ" association. We have proposed to fabricate a part for the shock absorber from powders. This part is produced in quantities of 1 million units per year. We have developed the production methods, designed the equipment, fabricated prototypes and experimental lots and have tested them. They will make these parts themselves later on. Now the engineering services of all of the association's plants have received the task of selecting a list of the parts which are more efficiently fabricated using powder metallurgy methods.

This approach is still the most widespread. Thus, we have developed and transferred to the Nesvizh association "Sel'khoztekhniki" the production methods for fabricating several parts for potato-picking combines. Now the association is fabricating them for the needs of the whole republic, and is even supplying them to the plant which manufactures the combines, satisfying a part of their requirements.

Close connections have been established between us and one of the country's radio industry plants. We have developed the production methods for making a mass part from powders for them. No longer having to produce them using traditional stamping methods has permitted them to reduce the labor-intensity to one-tenth the previous level and will save the plant 500 tons of brass yearly.

It has been decided to create an automated line equipped with robots, electronic control, etc. Other design bureaus and plants are designing and fabricating all of this to the plant's order. Our task is to assemble this line here in experimental production, debug it, initiate production with it and teach people and transfer the operating equipment, together with the production techniques, to the plant.

We are delivering powder molds to 6 porcelain plants in the country, including the Minskiy and Dobrushkiy plants. If one considers that each one of our molds permits a savings of R 60,000, it is clear that the collaboration will be mutually profitable.

[Question] Consequently, you are expanding to entire sectors of production?

[Answer] Just so, and this is most proper. The problem of concluding long-term agreements calling for completion of scientific research and experimental design developments, the creation of technological processes and training of cadres is posed for us in the eleventh five-year plan. Thus, our "output" will be finished production processes and specialists capable of realizing them.

But another thing is also clear: it is only possible to realize a similar system with the assistance of the ministries. Only by becoming an industry will we be permitted to use the advantages of advanced socialism most completely. In the first place, we will be able to understand the volumes and problems of the ministry as a whole on a broader scale, not being ground down, wrapped up in the current business of a single enterprise, but solving questions of promise for the national economy. In the second place, it would be easier to lean on the assistance of industry to improve our scientific potential.

[Question] Over a 4-year period, the economic savings from using the developments of the institute have increased fourfold, and should reach R 6 million this year. Producing an 8-million ruble savings is being projected for the end of the five-year plan. Obviously, it is impossible to realize such tempi by an increase in the material base alone, or by using new organizational decisions. What other measures are you carrying out?

[Answer] People carry out any kind of business. Therefore, the first problem is preparation of cadres. We have searched for and are continuing to search for gifted people in the Polytechnical Institute. We try to stimulate a yearning for study and creative growth in the workers and technicians who work in our laboratories and in experimental production. A significant part of our collective has grown in just this manner. As a result, 45 candidates of science are working at the institute, and 4 doctoral dissertations have been defended on the subjects of our scientific research institute. A department of powder metallurgy has been set up at the BPI. The Ministry of Higher Education, USSR has proposed opening the first department in the country specializing in our problems at the BPI. Enterprises direct graduate engineers here for study, and the engineers are retrained, receiving the necessary knowledge in the area of powder metallurgy in 6 months. This helps us to realize our principle: to keep the connection with the enterprises through the cadres and joint scientific research operations.

[Question] The developed system for preparing highly qualified specialists is an important matter. But there is still a second side, the education of people.

[Answer] And we don't forget about this for a minute. In fact, what is the task of the Institute's directorate, its Party organization? To determine what the collective should do and which scientific and technical means and approaches should be used. But the problems before us, as you may be assured, are very great, and if people work, as they say, "with their nose to the grindstone," nothing will come of it. Enthusiasm, initiative, the quest are needed; an active living position is necessary. The Institute's Party organization plays a very large role in developing such qualities in the workers of our collective.

We utilize various means for ideological-political and educational work, tested forms of political training for the collective. Our engineers and scientific workers have their own creative plans; a system for reviewing the competition and for determining the creative contribution of each worker has been developed and has been in use for more than a year. The party prompts us with the fact that accelerated scientific-technical progress is a most important social and educational problem. Its solution insures the growth of creative elements in labor and creates conditions for the professional and moral growth of the man. The administration and the Party organization strive to conduct their own work so that each one might consciously judge the problems standing before the collective and have the opportunity of expressing his opinion as plans are being discussed, to show his initiative. This is being stimulated here both morally and materially.

We do not hide the complexities in the solution of one problem or another from our people, but we show them clearly the goals whose achievement will repay our expended efforts a hundredfold. To create a pilot plant which will, in addition to everything else, save the country 15,000 tons of metal annually and liberate hundreds of people and hundreds of machine tools, is a great and an actual goal. To provide the porcelain industry with powder molds, thereby saving 25,000 tons of plaster of paris annually is an important task...

We are trying to instill in people a sense of international solidarity, actively drawing them into the realization of the six scientific and technical programs in whose completion we are participating along the line of the CEMA [Council for Economic Mutual Assistance]. In three of the programs, our institute is the chief scientific organization.

[Question] As is the case in any new business, many difficulties arise when solving complex problems. What difficulties do you have?

[Answer] The fact that we at times begin to get stuck in "little things" alarms me somewhat. We are carrying on interesting work, they praise us for good use of scientific equipment, but this equipment was obtained on the side. We do not think about developing our own, although it is necessary for carrying out fundamental research. As a result, we begin to "erode" our scientific reserve. At the XXV session of the Party, comrade L. I. Brezhnev noted, "We understand full well that the deep stream of scientific and technical progress will dry up if it is not constantly fed by fundamental research." And this means that we cannot allow ourselves to fall behind in science, particularly in light of those great problems which have been posed for us.

We must also resolve the questions of preparation of scientific cadres with higher qualifications more surely. In the next 4-5 years, a minimum of 6 doctors of science will be required for the Institute. We have people whose volume of work, preparation and erudition create the prerequisites for a solution to this problem. There are also publications and patents and developments which have been used, but this is no time to stop for a while to survey what we have already gone through, to generalize on what we have accomplished.

Concerning the, what you may call the external difficulties, the first of them are the powder materials, the quality and quantity of which cannot satisfy us now. The second is the technological equipment. At times it is even inferior to laboratory equipment. Let us say that the degree of rarefaction in laboratory vacuum ovens is three orders higher than that of the industrial ovens produced by the Ministry of the Electrical Engineering Industry, and this means that the production techniques which have been developed at the Institute may by no means always be transferred to production without significant adjustments.

Questions of providing the appropriate forging and press-molding equipment for fabricating items from metal powders, the machine tools and machines for working them are solved slowly. No one is concerned with producing non-standard equipment--misers, sieves, crushers etc. for practical purposes.

And nevertheless, we are sure that, with the attention which is being paid to us, the current problems will be solved.
[30-9194]

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SOME FEATURES OF THE VACUUM EXTRUSION OF METAL POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 8, Aug 79 pp 17-21 manuscript received 14 Nov 78

DOROFEYEV, YU. G., GORSHKOV, S. A. and YEGOROV, S. N., Novocherkassk Polytechnical Institute

[Abstract] A study was made of the effect of air on the density and strength of cold-pressed powder samples and the elastic aftereffect in them. Grade P[illegible]3 iron powder was pressed in both air and in a vacuum and the results compared to determine how much air remains in the parts after the compacting process. It was found that the gases, caught in the pores of cold-pressed samples, significantly influence both the strength of the intercontacting bonds and the magnitude of elastic aftereffect. The main cause of decreased porosity in samples pressed in air was the air pressure in the pores which "pushed apart" the contacting particles. At the instant of pressing a powder in a gaseous medium, the gas is trapped in the pore but, after removal of pressure, some of the pores are exposed which causes an increase in the degree of elastic interaction. As a result of the sharp increase in intercontacting bond strength in comparison with stresses, caused by the gas pressure at the contacting surfaces, the number of exposed pores and the elastic aftereffect are decreased and the fraction of exposed pores is increased. Upon increasing the compaction rate, the gas flow drops while elastic aftereffect rises. Figures 3; references 2 (Russian).
[8-6368]

Steels

CARBONITRIDE STRENGTHENING IMPROVES STRUCTURAL CHARACTERISTICS OF STEEL

Moscow PRAVDA in Russian 16 Sep 79 p 3

[Article by Academician S. Vonsovskiy, Chairman of presidium, Ural Scientific Center, USSR Academy of Sciences: "A Strengthening Effect"]

[Text] Sverdlovsk--Blast furnaces with volumes of 3,200 to 5,000 cubic meters: there are a few of them in this country now. These are immense installations, tremendously powerful furnaces. But a major factor in their successful construction has been special carbonitride-strengthened structural steels. If it were not for them, the thickness of the walls of the blast-furnace casing would have had to be twice as thick. Under certain conditions, a wall of such a thickness might collapse as a result of its own excessive weight.

Consider the cranes with a capacity of 1,200 tons at the Volgodon Atommash plant. Making them out of the metal which was used hitherto would mean ignoring the margin of safety. Here too carbonitride-strengthened steel came into play. It has been used in the lighter metal constructions for the shops of a number of ore enrichment combines and machine building plants and in highway and railway bridges (particularly on the BAM [Baykal-Amur Railroad]), and on television towers and similar structures.

Just what kind of a steel is this? It is made with the admixture of a slight quantity of vanadium (hundredths of a percent) together with nitrogen, aluminum and certain elements. Tiny particles of carbides and nitrides are formed. It is these which make the metal fine-grained and sharply improve its quality.

This fundamentally new method of producing high-strength steel was made available as a result of many years' research, primarily by the staff of the Ural Scientific Research Institute of Ferrous Metals, headed by its director Dr of Economic Sciences V. I. Dovgopol.

A major contribution to the solution of the problems of comprehensive testing and expensive utilization of this new method was made by the collectives of the Central Scientific Research Institute of Ferrous Metallurgy, the Central Scientific Research and Planning Institute of Structural Members, the Ural Polytechnic Institute, and enterprises of the USSR ministries of Ferrous Metallurgy and Installation and Special Construction Work.

The steel is 20 to 30 percent stronger than carbonitrided carbon steel. This results in smaller cross section and less weight of structural members made from it, and naturally an immense saving of metal, amounting every year to hundreds of thousands of tons, valued at over 30 million rubles.

Finally, carbonitride-strengthened steel has yet another extremely valuable property: cold resistance. At -40°, carbon steel loses its toughness, so that structural members made from it fail several times faster than under ordinary conditions. But carbonitrided steel can sustain a temperature of -60 to -70°. This is especially important in connection with the continually increasing pace of development of the North, Siberia and the Far East.

At present the USSR holds first place in the world in the production of carbonitrided steel. This is a major success for our metallurgy and a major achievement by a creative collective, the results of whose work have deservedly been nominated for a USSR State Prize.
[187-8480]

8480
CSO: 1842

THIRD-QUARTER METALLURGY PRODUCTION FIGURES REPORTED

Moscow TRUD in Russian, 20 October 79, p 1

[Article by A. Dimitrevskiy Secretary of the Central Committee of the Metallurgical Industry Worker's Trade Union and Ye. Druzhnev, Chief of the Production Work and Wages Section of the Trade Union Central Committee: "For Metal of Excellent Quality"]

[Text] Steel Makers

With each passing year more and more shop, shift, section, and unit collectives are joining the competition under the motto of "For High Quality Steel." Teams of steel makers at 41 enterprises of the metallurgical industry are participating in the socialist competition to smelt steel on order, with a high quality, and with minimum expenditures.

The experience in concluding socialist competition contracts with the collectives of related productions -- blast furnace workers, rollers, repair workers, and transportation workers upon whose work the success of the entire collective depends -- has become widespread among the country's steel makers.

The collectives of the Vyksa and Taganrog metallurgical plants, "Serp i Molot," and of the Norther Pipe Plant overfulfilled their commitments in the third quarter.

Great labor successes were achieved during the third quarter by the steel maker teams led by the following people: B. Karimov from the Vyksa, N. Eknadiosov from the Tuganrog, N. Firsov from the Novolipetsk, and N. Sil'chev from the Kommunarskiy metallurgical plants; S. Ptushko from the Northern Pipe Plant, Yu. Boyarinov from the "Sibelektrostal'" Plant, V. Chumanov from the Magnitogorsk Metallurgical Combine, and A. Zhunusov from the Karaganda Metallurgical Combine. During the third quarter these teams alone produced 4,108 tons of above-plan steel.

But there are also collectives which did not cope with their commitments. Nine enterprises did not fulfill their commitments for all indicators;

22 collectives did not meet their schedules for smelting steel to order; and 17 enterprises did not fulfill their commitments for smelting steel with a lower chemical composition than is called for by the state standards.

The collectives of the Kuznetsk Combine and the Makeyevo, imeni Dzerzhinskiy, and Western Siberian Metallurgical Plants permitted a large amount of lagging in the production of steel.

Violations of production discipline, accidents at individual units of equipment and insufficient raw material supplies continue to be the chief reason for the poor work of lagging collectives.

Table 1

1. Fulfillment of socialist commitments for the first quarter of 1979 by the collectives of metallurgical enterprises which are participants in the competition for smelting top quality steel. (Commitments and actual.)

2. Enterprises	3 Steel smelted with lower chemical composition than called for by state standards (In percentage of total smelted steel)		4 Fulfillment of weekly schedule for smelting steel to order (In percent)		5 Above-plan steel production (Thousands of tons)	
6. Vyksa Plant	93,0	93,1	98,5	98,6	2,5	2,08
7. Northern Pipe Plant	93,0	96,9	98,5	100,0	2,5	0,9
8. Taganrog Plant	94,5	95,3	98,0	98,1	2,8	0,178
9. "Serp i Molst" Plant	50,0	53,4	97,0	97,8	1,0	1,57
10. "Elektrostal'" Plant	90,0	90,0	94,0	92,0	2,5	0,515
11. Orsko-Khalilov Combine	75,0	85,8	97,1	91,4	5,0	1,326
12. "Krasnyy Oktayabr'" Plant	95,0	95,1	98,5	96,2	4.0	0,105
13. "Sibelektrostal'" Plant	97,0	97,2	99,0	96,5	0,4	0,19
14. Zlatoust Plant	94,0	97,5	98,5	91,2	6,0	0,564
15. Magnitogorsk Combine	90,0	85,6	99,1	99,0	25,0	8,8
16. lys'va Plant	55,0	49,0	98,0	100,0	2,5	0,614
17. Omutninsk Plant	95,0	94,8	95,0	90,6	2,0	0,545
18. Plant imeni K. Libknecht	80,0	76,1	97,0	95,9	2,5	0,590
19. Chelyabinsk Plant	95,0	95,0	95,0	97,0	20,0	-29
20. Petrovsk-Zabaykal'sk Plant	70,0	68,0	97,0	95,0	1,5	1,0
21 Beloretsk Combine	99,0	98,0	98,0	97,0	2,0	-6
22. Donetsk Plant	93,0	93,0	96,0	98,76	6,0	-0,911
23. Rustava Plant	91,0	91,0	96,0	96,0	2,5	-2
24. "Oneprospetsstal'" Plant	80,0	84,1	98,0	89,6	10,0	-15
25. "Azovstal'" Plant	76,5	76,5	98,2	97,9	10,0	-3,2
26. Kramatorsk Plant	80,3	92,8	98,0	99,0	3,0	-3,6
27. "Sarkanays-Metallurgs" Plant	70,0	70,3	98,2	98,7	5,0	-4,9
28. Plant imeni Petrovskiy	92,7	96,6	97,0	97,9	8,0	-7,546
29. "Amurstal'" Plant	70,0	72,1	97,4	99,2	10,0	-9,6
30. Novolipetsk Plant	97,7	97,9	97,8	94,7	30,5	-70,0
31. Chusovoy Plant	75,0	79,7	97,0	95,7	8,0	-13,857
32. "Zaporozhstal'" Plant	85,0	86,0	97,0	87,5	12,0	-39,4
33. Kommunar Plant	87,0	89,0	97,0	92,0	5,0	-106,5
34. Yenakiyevo Plant	55,0	65,0	97,0	89,0	3,0	-121,3
35. Plant imeni Dzerzhinskiy	85,0	85,0	97,0	94,0	20,0	-236,3
36. Sulinskiy Plant	74,0	69,8	98,0	94,3	1,0	-0,012
37. Plant imeni Serov	95,0	82,3	97,0	95,4	6,0	-29,83

[Table continued on following page]

[Table 1, continued]

38. Uzbek Plant	65,0	42,7	89,0	92,2	5,0	-2,6
39. Cherepovets Plant	94,0	87,6	97,0	89,0	40,0	-40
40. Karaganda Combine	97,0	94,4	97,0	96,2	20,0	-58,28
41. Plant imeni Il'ich	95,0	96,2	95,0	94,7	7,0	-62,8
42. "Krivoyrozhstal'" Plant	70,3	70,0	97,0	96,0	15,0	-290,0
43. Nizhnetagil Combine	95,0	81,4	99,1	95,4	15,0	-94,23
44. Western Siberian Plant	90,0	89,0	97,0	96,1	6,0	-117,1
45. Makeyevo Plant	92,0	91,8	97,0	93,0	6,0	-150,9
46. Kuznetsk Combine	90,0	88,8	97,2	94,3	12,0	-157,2

Rollers

Six teams of rollers at ferrous metallurgy enterprises which were the first to support the initiative of the steel maker at the "Azovstal'" Plant, the twice Hero of Socialist Labor G. Borban', who called for the organization of a socialist competition under the slogan of "From Top Quality Steel to Rolling to Order With the State Token of Quality," continued during the third quarter their struggle to supply only high quality metal to consumers and strictly in accordance with orders. The participants in the contract basically met their commitments.

The best indicators in the competition of the third quarter, as of the first and second quarters, was achieved by the team of M. Kushchev from the Donetsk Metallurgical Plant. During the third quarter alone the team produced 229 tons of above-plan high quality metal.

Good indicators were achieved during the third quarter by the team of A. Kreshchanovskiy from "Azovstal'." Its above-plan production came to 1,552 tons of metal. Stable indicators for the production of above-plan rolled goods were achieved during the quarter by the team of V. Popov from the Magnitogorsk Combine. During the third quarter the team of A. Tsukanov from the Novolipetsk Plant economized 7,167 tons of metal.

The work results of the branch's rolling shops could have been better if there had been more rhythmic work by the steel makers of certain enterprises.

The teams of V. Popov from the Western Siberian Plant and N. Belunichev from the Cherepovets Plant created a large debt in above-plan rolling. The steel makers of these enterprises did not fulfill their plan for the production of steel, which had an effect upon the work of the roller teams participating in the contract. The trade union plant committees did not take the necessary measures in time to organize an effective competition between related workers and the collectives of steel makers and rollers. The rolling shops are not being supplied with the necessary amounts of metal.

The task of the economic executives and trade union committees of enterprises is to provide all of the necessary conditions for competing teams of steel makers and rollers for their fulfillment of their socialist commitments for 1979 in steel making and rolled goods of excellent quality.

Table 2

1. Results of a fulfillment of commitments for the third quarter of 1979 by the collectives of 6 teams of rollers participating in the competition for the production of metal of excellent quality.

2. Enterprise Team Leader	3 Fulfillment of orders (In percent)		4 Above-plan production of rolled goods (In tons)		5 Increase in production of first grade ready rolled goods (In percent		6 Metal Economy (In tons)	
	7 Commitments	8 Actual	com.	act.	com.	act.	com.	act.
9. Donetsk Plant M. Kushchev	99.8	99.9	300	229	99.5	99.5	50	12.6
10. "Azovstal'" Plant A. Kreshchanovskiy	99.6	97.9	750	1552	100.0	100.0	125	73
11. Magnitogorsk Combine V. Popov	100.0	98.2	600	270	99.9	99.95	2000	252
12. Cherepovets Plant N. Belunichev	100.0	99.9	500	-2217	99.0	99.8	1000	-70
13. Novolipetsk Plant A. Tsukanov	100.0	99.0	5000	850	99.5	98.8	15000	7167
14. Western Siberian Plant V. Popov	100.0	85.9	300	-12642	98.8	99.02	4000	604

2959
CSO: 1842

USSR

STRUCTURAL MECHANISM OF HARDENING OF 9Kh2 STEEL UNDER ELECTRIC-SPARK TREATMENT

Kishinev EKETRONNAYA OBRABOTKA MATERIALOV in Russian No 4, Jul/Aug 79 pp 9-12

NAZARETS, V. S., BELOBRAGIN, YU. A., SOTOV, I. N. and RYBETS, M. A., Tula

[Abstract] A study was made of the surface layer produced by electric-spark treatment of 9Kh2 steel. Its properties and structure were examined by means of microhardness tests, optical metallography, x-ray and electron diffraction, and transluminaton electron-microscopy. Microhardness measurements revealed the existence of three zones under the surface: a 10-15-μm-thick very hard fusion layer, a deeper 10-15-μm-thick secondary-quench layer as hard as the quenched core material and a 30-μm-thick softer annealed layer. The surface layer essentially contains martensite with dispersion differing from the original and with residual austenite in the white fusion zone. As the mosaic structure breaks up, microstresses at the treated surface exceed the strength of quenched 9Kh2 steel (3.5 GPa), but no surface cracking occurs during subsequent treatment and the surface layer remains hard. Structural changes depthwise are produced by interaction with carbon and its subsequent precipitation, and the eventual formation of carbides in the fusion layer (but not in the secondary-quench layer) contributes to wear resistance. Figures 3; references 13 (Russian).
[1-2415]

USSR UDC 539.4

INFLUENCE OF CARBON ON THE RESISTANCE OF CONSTRUCTION STEELS TO FAILURE

Kiev PROBLEMY PROCHNOSTI in Russian No 5, 1979 pp 64-68 manuscript received 26 Sep 77

LAZ'KO, V. G., LAZ'KO, V. YE., OVSYANNIKOV, B. M. and FONSHTEYN, N. M., Moscow

[Abstract] A study was made of six steels having carbon contents ranging from 0.12 to 0.60% to study their resistance to deformation and failure. The samples had different limits of strength ranging from 110 to 180 kg/mm^2 due to the different heating regimes used during their heat treatment. The experimental data indicate that changing the carbon content in steels having the same strength did not significantly change the resistance to failure of the medium-alloy construction steels. However, the process of intially

establishing the strength is most significant. Steels having a low-temperature martensite structure show a high resistance to failure compared with those having the same strength but a high-temperature tempering. With an increase in carbon content, the specific viscosity decreases markedly over all temperature ranges used for the tempering. Figures 7; references 11: 1 Western, 10 Russian.

USSR UDC 548.4

CHANGES IN THE PHASE COMPOSITION AND STRUCTURE OF THE SURFACE LAYERS OF STEEL BOMBARDED WITH MOLYBDENUM IONS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, 1979 pp 19-26 manuscript received 13 Feb 79

BREN', V. G., KUNCHENKO, V. V., MIROSHNICHENKO, YU. T., MOROZOV, A. A., KALININ, A. T., REKOVA, L. P. and MASHTAKOVA, G. S., Khar'kov

[Abstract] The interaction between a molbdenum plasma flux and specimens of various steels (20Kh2N4A, 40Kh, and St.45) was investigated. Ion bombardment of the specimens was accomplished in a vacuum chamber on using pure vacuum-melted molybdenum as the cathode and accelerating the molybdenum ions by applying a negative potential of -1 kv to the specimens; allowing for the multiple charge of the ions, the mean energy then is ~3 keV. Such bombardment was found to result in changing the morphology of the surface layers of the specimens, to an extent depending on the state of the material and the temperature of the plasma flux. A martensitic structure is observed after bombardment at 200°C; a sorbitic structure, after bombardment at ~400°C; and a troostitic structure, after bombardment at 600°C. The nature and extent of the etching and sputtering of the surface layers depend on the phase composition and the structural state of the material. The interaction between the plasma flux and steel results in the formation of sectors of condensed molybdenum on the steel surface, as well as in the combining of molybdenum with the steel's components and with residual gases. The number of the resulting compounds (molybdenum carbides and nitrides) tends to increase with an increase in substrate temperature from 200 to 600°C. The high degree of the ionization of molybdenum (~90%) warrants regarding this entire process as a process of interaction between low-energy ions and substrate material. Such interaction results in the purification and activation of the surface layer and the sputtering of the target material. Figures 3; references 35: 23 Russian, 12 Western.
[173-1386]

USSR UDC 539.219.3

DIFFUSION PROCESSES UNDERLYING THE CHEMOTHERMAL TREATMENT OF STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA MATERIALOV in Russian No 8, Aug 79 pp 39-43

KRISHTAL, M. A. and VOLKOV, A. I., Tol'yatti Polytechnic Institute

[Abstract] The problems in chemothermal treatment of steel, namely in developing a diffusion link, are analyzed on the basis of equilibrium and quasi-equilibrium relations involving both the chemical potentials and the thermodynamic activities of carbon in carbon steel, in alloy steel, and in air, respectively. Calculations yield the carbon concentration at the surface, with the concentration of an alloying metal then being found with the aid of the diffusion equation and experimental data. With these results it is now possible to determine the necessary depth of the diffusion zone and the minimum length of the diffusion process to yield a favorable structure of the diffusion link during cementation. The results of this analysis have been successfully applied to chromization of porous iron by thermodiffusion in vacuum concurrent with chemothermal treatment. References 5 (Russian).
[12-2415]

USSR UDC 621-977:669.15-194.2

INFLUENCE OF COOLING DURING DEFORMATION ON RETENTION OF THE EFFECT OF HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT DURING HOT ROLLING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA MATERIALOV in Russian No 8, Aug 79 pp 30-31

PODGAYSKIY, M. S. and KHLESTOV, V. M., Donets Scientific Research Institute of Ferrous Metallurgy

[Abstract] The results of high-temperature thermomechanical treatment of steel are related to changes in the austenite structure such as grain comminution and polygonization due to hot deformation. During cooling, moreover, the critical temperatures of austenite transformation to ferrite-pearlite and ferrite-bainite become higher. In a study of low-carbon and low-alloy steels the effect of the cooling rate on the magnitude of these temperature shifts was measured and the latter used as a criterion of retention of the treatment results. The data indicate that the results of high-temperature thermomechanical treatment cannot only be retained but also promoted by a proper regulation of the cooling rate during hot rolling from above 1000°C. This applies to almost all low-carbon and low-alloy grades of strip steel. G. K. DOROZHKO and N. I. YEGOROV participated in the study. Figures 2; references 4: 3 Russian, 1 Western.
[12-2415]

USSR UDC 669.71:539.216.2:536.212

HEAT CONDUCTIVITY OF THIN POLYCRYSTALLINE ALUMINUM FILMS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 6, 1979 pp 1300-1301 manuscript received 19 Apr 78

PUGACHEV, A. T. and BRATSYKHIN, V. M., Khar'kov Polytechnic Institute imeni V. I. Lenin

[Abstract] Experimentally established heat conductivity coefficients λ of thin metal films are lower than the λ_0 of bulk metals. With increase in film thickness t heat conductivity increases, which is in agreement with the classical size effect theory for metals in which the electron part of heat conductivity exceeds the lattice part. However, the experimental findings on λ show it to be even lower than the values predicted by that theory, and that not only for film thicknesses commensurate with the electron free path l_0 but also for the $t \gg l_0$ range. This discrepancy between theory and experiment is attributed to failure to consider the structure of the polycrystalline films of many metals, and specifically to the exceptionally high density of block boundaries in such films, which reaches 10^8-10^9 m^{-1}. In this connection it is shown that collating the earlier experimental findings on the heat conductivity of thin polycrystalline films of aluminum with subsequent research into their structure admits a quantitative description of the relationship of heat conductivity to film thickness within the framework of the size effect theory. Figures 2; references 14: 6 Russian, 8 Western. [178-1386]

USSR UDC 533.9; 539.23

HIGH-FREQUENCY INDUCTION PLASMA TREATMENT OF THIN ALUMINUM FILMS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV No 4, 1979 pp 74-77 manuscript received 29 Aug 77

ABDULLIN, I. SH., VDOVIN, D. A., SHARIFULLIN, S. N. and SHCHERBAKOV, V. D., Kazan'

[Abstract] Treatment of coatings with high-frequency induction plasma (HFIP) with the object of improving their electrophysical and mechanical properties is of interest. In this connection, the variation in the surface resistivity R_0 and temperature resistance coefficient (TRC) of aluminum films under the action of low pressure HFIP was investigated on 0.06-, 0.12- and 0.8-μm-thick aluminum films vapor-deposited on pyroceramic substrates at 120°C. The films

were placed in a vacuum chamber and treated with argon that was induction-heated to the plasma state and discharged into the chamber at rates varying from 0.02 to 0.18 $g \cdot sec^{-1}$. The optimal gas discharge rate at which the maximal irreversible decrease in resistivity was found to be 0.06 $g \cdot sec^{-1}$ for the 0.12-μm-thick film--then R_0 decreases by 30%. For thicker films the optimal argon discharge rates are higher and the decrease in their R_0 reaches 50%. TRC also decreases (from 18 to 1.12, from 1.5 to 1.35, and from 1.39 to 1.2, respectively for 0.06-, 0.12- and 0.8-μm-thick films) following HFIP treatment. The simultaneous decrease in R_0 and TRC of the films denotes an increase in the stability of the films. This is of interest to the development of measuring instruments whose film components should not change in resistance with change in temperature. Figures 2; references 8 (Russian). [173-1386]

USSR UDC 621.791.3:621.785.3:669.295

SELECTION OF THE HOMOGENIZING TEMPERATURE OF BRAZED JOINTS OF VT6S TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, 1979 pp 22-23

BESEDNYY, V. A. (deceased), and KANDYBA, YE. F., All-Union Scientific Research Institute of Compressor Machinery Industry

[Abstract] This is a continuation of earlier studies (V. A. Besednyy, SVAROCHNOYE PROIZVODSTVO, No 7, 1975; No 1, 1977; No 11, 1976) which showed that brazed titanium-alloy joints are structurally inhomogeneous and contain a brittle eutectic interlayer which adversely affects their mechanical properties. Since the homogenizing of brazed joints reduces their concentrational and structural inhomogeneity, the selection of optimal homogenizing temperature for brazed joints of VT6S titanium alloy was investigated. The active metal in the contact-reactive brazing was M1 copper foil. The brazed specimens were homogenized at 700 to 1050°C, through every 50°C, for 4 to 14 hrs. Analysis of the experimental findings showed that the maximum growth rate of width of the joint and of thickness of the intermetallic compound T_2Cu, along with the attendant maximum extent of equalization of structural inhomogeneity of the joints, is observed at 875-925°C. Changing the time of homogenizing from 4 to 12 hrs had no effect. Tensile and impact bending tests of brazed joints thus obtained produced satisfactory results. This demonstrates the possibility of the practical application of honogenizing at 875-925°C to obtain brazed joints with a low residual concentrational and structural inhomogeneity and with high mechanical properties. Figures 2; references 5 (Russian).
[179-1386]

USSR UDC 620.178.169:669.295

WEAR RESISTANCE OF TITANIUM ALLOYS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 7, 1979 pp 34-35

VAYSMAN, B. L.

[Abstract] Soviet industrial enterprises use a great deal of VT1-0 and OT4-0 titanium alloys in building technological equipment, particularly for gas transportation systems and various kinds of containers. This entails wear of pipe materials since the gases transported contain considerable quantities of solids with abrasive properties, which compounds the effect

of gas-caused corrosion. In this connection the wear resistance of the above alloys was experimentally compared with that of Kh18N9T and St3 steels on a test stand with centrifugal acceleration of abrasive particles (electrocorundum powder No 16) within a rotating pipe at whose butt end the specimens were mounted. Specimens were bombarded by horizontal jet of abrasive (concentration, 50 g/m^3; rate, 19.5 m/sec) for 45 minutes. The tests showed that in air at normal temperatures the wear of titanium alloys was 35% greater than that of Kh18N9T steel and 30% greater than that of St3 steel. At 350°C the wear rate of titanium alloys decreased to its minimu, however. Since this cannot be attributed to an increase in strength, the effect of oxide films on the wear of titanium alloys at high temperatures was investigated, and it was found that the reduced wear of these alloys at high temperatures is due to the attendant formation of increasingly thick protective oxide films, up to a point. Since titanium alloys are also used as the material for transporting the discharge gases of melting furnaces and kilns, the wear resistance of specimens of these alloys was tested in the presence of gases consisting of 13% CO_2, 5% O_2, 1% CO, and 5% H_2O, with N_2 as the remainder, on adding 0.5, 1, 2, 3, 4, and 5% SO_2. The tests showed that the pattern of the wear of titanium alloys in furnace-gas atmospheres resembles their pattern in normal air. It can be concluded that on heating in an oxidizing medium the wear rate of titanium alloys is minimal at 350°C, but increases again at higher temperatures. In the presence of corrosive-abrasive media of the furnace-gas type, titanium alloys are not superior to Kh18N9T steel. At up to 400°C the presence of up to 5% SO_2 in furnace gases does not affect the wear rate of titanium alloys, but at higher temperatures that rate increases when more than 1% SO_2 is present in the furnace gases. Figures 3: references 2 (Russian).
[180-1386]

Welding

USSR UDC 621.791.92.04

EFFECT OF THE METAL BATH GEOMETRY ON THE STRUCTURE OF A COMPOSITE ALLOY DURING ELECTROSLAG FUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 8, Aug 79 pp 58-60 manuscript received 19 Sep 78; after revision 31 Oct 78

SHEKHTER, S. YA., Candidate of Technical Sciences, REZNITSKIY, A. M., Candidate of Technical Sciences, RAZINSKIY, V. V., engineer, Welding Department, Donets Scientific Research Institute of Ferrous Metallurgy, Kommunarsk

[Abstract] A study was made to determine the dependence of structure of a composite welding alloy on the geometry of the metal fusion bath in the vertical electroslag process, particularly important being the thickness of the relit [tungsten-cobalt alloy] middle layer in the 3-layer structure and the packing density of reinforcing grains in that layer. The laboratory equipment consisted of an ingot pulling mechanism, an electrode feed mechanism, a source of x-rays for radiography of the bath with the immersed electrode, and a special-purpose crystallizer. The test results indicate that relit grains sink into the bath due to gravity and, sliding along the walls, concentrate in the bottom part so as to build up the 3-layer structure of the composite welding alloy. The packing density of relit grains in the middle layer increases as the thickness of this layer decreases with greater steepness of the walls. Another factor which influences the packing density of relit grains in the powder density in the slag bath. Figures 3; references 6 (Russian).
[13-2415]

USSR UDC 621.791.01:620.192.46

INCREASING THE RESISTANCE OF HEAT RESISTANT ALLOYS TO HOT CRACKING DURING ELECTRON-BEAM WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 8, Aug 79 pp 52-55 manuscript received 15 Dec 78

MOROCHKO, V. P., PANOV, YU. P., SOKOLOV, A. N., engineers, Moscow

[Abstract] A study was made to determine the feasibility of faster electron-beam welding without hot cracking of the seam. It has been established experimentally that cracking of the metal becomes most intensive when the isothermal interphase boundary bends in the longitudinal section of the seam and thus a zone of higher micrononhomogeneity is formed with a resulting

concentration of plastic strains across the joint. To avoid this, it was found necessary to lower the pressure of metal vapor and gases by reducing the beam power density in the welding bath and to alloy the seam metal with elements forming a tough interlayer. Tests were performed with 10-15-mm-thick specimens of KhN45MVTYuBR and KhN62VMYuT dispersion-hardening nickel alloys. The best result, a welding rate of 30 m/hr, was attained with an electron beam either oscillating at a frequency of 30-50 Hz to an amplitude of 3-5 mm or pulsating at a rate of 40-70 Hz and off 10% of the cycle, and by adding 8-10% cobalt or tungsten powder to the seam metal. Figures 4; references 10: 6 Russian, 1 German, 3 Western.
[13-2415]

USSR UDC 621.791.793

DURABILITY OF WELDED JOINTS BETWEEN PARTS MADE OF TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 8, Aug 79 pp 56-57,60 manuscript received 5 Jun 78

KOMPAN, YA. YU., Candidate of Technical Sciences, PEREPECHKO, N. S., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] Titanium alloys under mechanical stress at high temperature are prone to corrosion cracking in the presence of chlorides. This factor must be considered in the development of an electroslag welding technology. Titanium alloys of the $\alpha + \beta$ group are particularly vulnerable and, therefore, a study of the VT6 and VT22 alloys was made at the Institute of Electric Welding. Separate and joined specimens, cylindrical and flat, were coated with thin films of a 3% NaCl solution and then tested for tensile strength at 530°C over a period of 1000 hrs under loads of 10, 10 and 30 kgf/mm^2. While the VT6 alloy was found to have greater immunity to salt than its welded joint, both the VT22 alloy and its welded joint yielded to salt corrosion under a load of 20 kgf/mm^2 after 70 hrs. Heat treatment during welding contributes to the loss of strength. Figures 3; references 3 (Russian).
[13-2415]

USSR UDC 621.791.754'293:669.715

ON THE MECHANISM OF THE BREAKDOWN OF OXIDE FILMS AT THE BUTT DURING ARGON-ARC WELDING OF ALUMINUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 79 pp 25-26

YUSUFOVA, Z. A., Candidate of Technical Sciences

[Abstract] Welding of aluminum alloys is detrimentally affected by oxide films at the surface and inclusions they leave in the same metal. A study of the thermal mechanism of their breakdown, necessary for successful welding, was made in an experiment where disk specimens of the AMg6M aluminum alloy were welded together with a tungsten electrode in an argon arc. The results of x-ray analysis and layerwise micrstructural examination of cross-cuts and fractures reveal that oxidation ahead of the arc is caused by a spreading of the thermal field with temperatures above 250° beyond the inert gaseous shield. The oxide films start breaking down beyond the welding pool, within a narrow transition zone where not all the metal has yet melted, and proceed breaking down toward the center of the pool, where the process is then completed. Figures 3; references 7 (Russian).
[29-2415]

USSR UDC 621.791.72:669.715'25'21

AMENABILITY OF ALLOYS OF THE ALUMINUM-BERYLLIUM-MAGNESIUM SYSTEM TO ELECTRON BEAM WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, 1979 pp 10-11

KOMAROV, M. A. and SHIGANOV, I. N.

[Abstract] The origin of defects in electron-beam welds of the Al-30 Be-5 Mg industrial alloy was investigated on the basis of the premise, taken from the theory of laser treatment, that surges of metal from the molten pool may be caused by forces arising during the boiling of the melt. In actual welding, boiling begins when the pressure in the gas bubble exceeds the external pressure. Accordingly, vapor pressure in the bubble was calculated by allowing for the fact that magnesium is the most volatile component of the solution. In cases in which pressure in the bubbles exceeds the external pressure, i.e., in the presence of boiling, defects are likely to form. When, however, the external pressure exceeds the pressure in the bubble, i.e., there is no boiling, a satisfactory weld is produced. On this basis it is

possible to estimate the probability of formation of weld defects for various alloys of the Al-Be-Mg system. The corresponding figures for two compositions of alloys of the Al-Be-Mg system and for the AMg6 alloy are tabulated, showing how the chemical composition of these alloys affects the formation of defects during their electron-beam welding. A formula serving to determine the critical molar part of magnesium as a function of the concentration of beryllium is presented. This formula is the criterion of weldability and should be taken into account when developing new compositions of weldable alloys of the Al-Be-Mg system with enhanced physico-mechanical properties. Figures 2; references 10: 9 Russian, 1 Western.
[179-1386]

USSR UDC 621.791.052:669.017.3

CONDITIONS OF STRUCTURIZATION OF THE SEAM METAL DURING WELDING OF HEAT-RESISTANT SHEET MATERIAL

Moscow SVAROCHNOYE PROIZVODTSTVO in Russian No 10, Oct 79 pp 4-7

SLAVIN, G. A., Candidate of Technical Sciences, KHOROSHEVA, V. B., engineer

[Abstract] The structurization of the seam metal during welding of heat-resistant sheet metals is analyzed theoretically on the basis of metallographic evidence and experimental data. A study was made on 1.5-mm-thick sheets of EI and VZh steels welded together with a continuous argon arc. The characteristics of the crystallization process, depending on the conditions of heat transfer, were established by measuring the angle between the direction of heat flow and the direction of grain growth. Dendrite growth in the initial direction was found to cease with this angle reaching its critical magnitude of 30-40° for these particular grades of steel. Otherwise the dendrite growth was found not to be subject to orthoganlity constraints and the macrostructure of all these grades of steel was found to be the same. A mathematical analysis, based here on an ellipsoidal shape of the crystallization zone in the welding pool, establishes the theoretical welding process conditions and, particularly, the welding rate at which transition from an axial columnar dendrite structure to a transcrystallitic structure occurs and how this transition point depends on the thermophysical properties of a particular metal. Figures 8; references 4 (Russian).
[29-2415]

USSR UDC 621.791.4:539.378.3

ALLOYING THE METAL IN THE JOINT ZONE DURING DIFFUSION WELDING OF THE OT4 TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 79 p 11

CHARUKHINA, K. YE., engineer, and GRIGOR'YEVSKIY, V. I., engineer

[Abstract] Addition of molybdenum, vanadium, niobium, or rhenium to titanium alloys during welding stabilizes their β-phase and lowers their resistance to plastic deformation under heat and pressure. Experimental diffusion welding of the OT4 α-phase titanium alloy has established that addition of any of these elements contributes to formation of a precise joint of uniform strength, regardless of the original metal structure and unlike the addition of zirconium forming a solid solution with titanium which detrimentally affects the joint formation. In the experiment cylindrical specimens 15 mm in diameter were welded under a pressure of 0.2 kgf/mm^2, with the temperature raised to 950°C by radiation and with the load maintained for 30 min. A high resistance to cracking, as well as a consistently high resilience, can be attained with a critical concentration of a β-stabilizing element. Figures 2; tables 1; references 3 (Russian).
[29-2415]

SUPERCONDUCTING SOLID XENON PRODUCED

Moscow PRAVDA in Russian 30 Sep 79 p 2

[Article by A. Presnyakov: "Even Xenon Has Become a Metal"]

[Text] So...the family of metals has been swelled by hydrogen and xenon. Many accepted concepts of physics are being inexorably shattered. Having learned to produce superhigh and superlow temperatures, outer-space vacuums and enormously high pressures, scientists have unprecedented capabilities for acting on matter and forcing it to fully reveal its properties.

It was during such a "dialog" with nature that the soft mineral graphite, when acted upon by superhigh pressures and temperatures, was converted into diamond and gaseous hydrogen was converted to the metallic state. These epoch-making experiments in high-temperature physics were led by institute organizer and eminent scientist L. N. Vereshchagin. Pursuing the activity which he led, scientists have carried out a series of experiments with another gas as well: xenon.

While many investigations and publications have been devoted to hydrogen, an element which is everywhere on earth and in the universe, xenon has hitherto not been the subject of such flattering attention.

What is known about it?

The gas received its name from the Greek word "xenos," which means "stranger." It was discovered by W. Ramsay and M. Travers. Xenon is present to a miniscule extent in the earth's atmosphere. Ramsay needed to process tens of millions of liters of air to obtain 300 cubic centimeters of xenon. Now its production has been organized, and it has become practically accessible for technological use.

Located practically in the center of Mendeleyev's table, in the 54th position, xenon belongs to the elite group of noble gases. The pages of its biography sparkle with a brilliant variety of "talents" that have been discovered. It radiates extremely bright light, comparable with that of the sun, and works in high-pressure gas discharge lamps. Xenon light sources are frequently given the affectionate name of "suns on earth"; they give almost natural light to streets, squares and railway stations. Luminous xenon has a beneficent effect on the green inhabitants of conservatories and greenhouses and helps bring color moving pictures to the screen.

The above does not exhaust the numerous "gifts" of xenon. Using this gas it has been possible to develop optical welding of metals with extra-high precision. It is used in laboratories for many physical and chemical processes.

Since the beginning of the 20th century, inert xenon has gained a reputation for intractibility among chemists. And for a long time no way was found to force it to enter into any chemical compound. Scientists did not know what could bring the inert gas out of its "equilibrium." But in 1961 a Canadian scientist, M. Bartlett, produced the first chemical compound containing xenon. Extremely active fluorine "untied the knot." Subsequently it become possible to produce compounds of other congeners of xenon.

Now, by the efforts of Soviet physicists, xenon has acquired another, perhaps its most astonishing, metier: it has shown the ability to be a metal with the properties of a superconductor. This is the fruit of an extremely important scientific and experimental quest. The complex cycle of theoretical and experimental work was carried out by the leader of the Institute of High Pressure Physics, Dr of Physical and Mathematical Sciences Ye. N. Yakovlev and his scientific colleagues Yu. A. Timofeyev and B. V. Vinogradov.

What was the scientists' path to the practical realization of the bold idea of producing metallic xenon? Here is what Yevgeniy Nikolayevich Yakovlev says about it:

"Back in the sixties investigators were already studying this gas under high pressure. Theoretical predictions indicated that it would be possible to effect a series of phase transformations as a result of which solid xenon would change from a dielectric (insulator) to a conductor and acquire the properties of a metal. It was estimated that this would occur at a pressure of 500,000 atmospheres. A success achieved at our institute, that of converting hydrogen into a metal, was an excellent school. And when we continued our researches with xenon, we acted even more boldly, using our accumulated experience."

And how was it possible to force xenon to become a metal with superconducting properties? The experimental leader explains:

"A special superhigh-pressure chamber made of polycrystalline diamond was cooled to a temperature below the melting point of liquid xenon: -112° C. Next we introduced gaseous xenon into the chamber through a heatable capillary. It immediately condensed and filled the chamber as a solid. A superhigh pressure was produced in the chamber. Precise measurements were taken. They showed that the electrical resistance of the solid xenon had begun to decrease sharply. In other words, it had passed over to the metallic state."

"As the cooling of the already solid xenon continued under superhigh pressures, and the temperature moved ever closer to that of liquid helium: -269°. The electrical resistance of the xenon continued to fall. And then arrived the moment when it began to show superconducting properties. This effect was established at a temperature of -266.2° C," concluded the scientist.

Thus yet another page has been written in the biography of xenon. A new and important stride has been made in the knowledge of matter, one towards production of materials with new and astonishing properties which are of great interest in both scientific and practical terms.
[6-8480]

8480
CSO: 1842

PROGRESS REPORTED AT THE CHEREPOVETS METALLURGICAL PLANT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 September 1979, p 2

[Article by M. Anan'yevskiy, director of the Order of Lenin Cherepovets Metallurgical Plant imeni the 50th Anniversary of the USSR: "On The Road to Big Metal"]

[Text] When we, the metallurgical workers of Cherepovets, discuss our problems and attempt to determine the sources of today's difficulties, we look back to the recent past when there was not enough conversion metal at the plant for loading the rolling mills. At that time we ourselves found a way out of the situation. In a very short time two open-hearth furnaces were reconstructed as two-basin furnaces and oxygen blocks were built. As a result, it became possible to sharply intensify the blast and open-hearth processes. Without commissioning new capacities output sales increased by 17 percent, and profits increased by 43 million rubles a year.

It cannot, of course, be said that all of the successes of the collective of the Cherepovets Metallurgical Plant belong in the past. But willy-nilly we have begun to distinguish periods in the life of the enterprise: before the commissioning of the "2000" mill and after it. What was described above was "before the mill." And "after it" we were showered with just criticisms by our metal consumers, and following upon them fines for many millions of rubles. The enterprise began to experience financial difficulties. Things went so far that a plant which provided the state with more than 250 million rubles in profits every year had gotten into the category of bankruptcy. What is the reason? The passionate dispute about whether or not there should be "big metal" in the center of the Russian North was long ago resolved in the affirmative. In the future the Severnaya Magnitka is supposed to double its production of all types of output. However, the correctly planned strategy still has to be backed up by correct tactical decisions. And here there proved to be much that was controversial.

The expansion of the plant began with the construction of roll cutting equipment -- that is, from the "tail-end." Rolls which we did not have: it was planned for them to be supplied from Lipetsk. This led to the fact that in three years only 1.6 million tons of metal was processed, while the equipment had an annual capacity of 2 million tons.

Then came the turn of the "2000" mill. To "feed" such a giant is an extremely difficult matter. And what could be counted upon if the plant did not have its own conversion metal: it had to be brought in from Zhdanov for the new mill. This placed the transportation in a difficult situation. Constant raw materials interruptions were a heavy burden for the plant. From the time that the powerful unit was put into operation the collective failed to produce around 3.3 million tons of various kinds of rolled goods as a result of a lack of raw materials.

With a raw materials hunger which had already become chronic it was not so easy to attain the capacity which had been established for the mill -- 4 million tons of rolled goods a year. But it is planned for us to roll 4.6 million tons. Is this realistic? I do not think so. But these 600,000 tons of "extra" metal have already been assigned to consumers. And with every right to do so they are making complaints against us with all of the material and moral consequences which follow from this for us.

Severnaya Magnitka is now entering a qualitatively new period of its history: By the end of this year the first stage of an oxygen-converter shop is supposed to be put into operation. Such a prospect, of course, is gratifying for us. However, our plant economists are already counting our losses. An old tune is being repeated to a new beat: "before the converter" and "after the converter." Concern is being caused not only by the fact that powerful highly productive equipment has to be mastered in a brief time: this is not new for metallurgical workers. It is being caused by the fact that in order to smelt converter steel a large amount of liquid iron is needed. And where is it to be gotten?

The plant has slightly more than a million tons of "free" iron which is planned for conversion. But this will by no means solve the problem of the efficient use of the converters. First, the iron we have is too little even for the period of the mastery of the equipment. Secondly, at the present time Cherepovets casting iron is received by more than [illegible] enterprises in the country among which are such large consumers as the Izhorsk and "Bol'shevik" plants, the Kirov plant in Leningrad, and others. To assign them to other suppliers and reorganize them for new raw materials can involve large losses.

It is completely clear today that the converter shop in Cherepovets will begin to work at full capacity only after the commissioning of our giant blast furnace with a volume of 5000 cubic meters. Our hopes of finally closing the technological chain are now connected with it. The larger the gap between the commissioning of the converter shop and the new blast furnace, the greater will the losses be. And not only for us, but also for numerous consumers. But with a normed blast furnace construction schedule of 2.5 to 3 years the underloading of the converters threatens to be drawn out.

However, there is still silence at the site of the future blast furnace. It is also disturbing that the plant does not have a reserve of prepared iron ore raw materials for it. This means that at the same time it will be necessary to build powerful sintering bands. But this is not all. When the giant blast furnace is commissioned a large quantity of secondary energy resources will appear -- blast furnace and coke gasses and coal enrichment wastes. Consequently, a second heat and energy station is needed....

The breaches in the technological chain which did not form yesterday are not so simple to patch up. It is connected, as we see, with the construction of facilities whose cost comes to tens and even hundreds of millions of rubles. Meanwhile, in Cherepovets, in our view, the forces of our construction workers and our material and technical resources are too scattered. With the present capacities of the city's construction organizations it is practically impossible to rapidly (in five to seven years) more than double the capacities of the metallurgical plant which were created over a quarter of a century. Moreover, to simultaneously build Europe's largest steel rolling plant, and also to build chemical and nitrogen fertilizer plants, and a number of other enterprises.

In order to cope with the large volumes of work the All-Union "Cherepovetsmetallurgstroy" association consisting of seven trusts was created on the basis of the "Cherepovetsmetallurgkhimstroy" trust. But this reorganization by itself has as yet produced little. In the last year of its existence the trust used almost 180 million rubles, while the association which has come to replace it has used only 176 million. In a year it was only possible to increase the amounts of construction work by 11 million rubles -- a drop in the ocean given our needs. It could not be otherwise, because the construction workers do not have a powerful industrial base whose creation is being impermissibly drawn out. The capital investments which are allocated for this purpose are not used year after year. In the decree of the CC CPSU and USSR Council of Ministers "On Improving the Planning and Strengthening the Influence of the Economic Mechanism on Increasing Production Efficiency and Improving the Quality of Work" it is stated that the capital construction plan has to be balanced with material and technical, labor, and financial resources and with the capacities of construction organizations. Capital investments have to be allocated for a planned increase in the amount of production.

In the light of this demand, it is obvious that it is necessary to direct the resources and efforts of the construction workers of the USSR Ministry of Heavy Construction toward closing the technological chain of the second stage of our enterprise as rapidly as possible. Only then will the country's already operating largest "2000" mill and the powerful oxygen-converter shop which will go into operation this year be able to achieve a real increase in the production of metal.

The essence of the problem, however, is not only in this. In order, in principle, to eliminate situations like those in which the Cherepovets plant has found itself it is necessary to have a more careful look at the planning practice which has developed in ferrous metallurgy. It is customary to look upon this branch as a single enormous enterprise with this one difference that its shop plants are scattered throughout the country. From this point of view disproportions in the development of individual plants are masked and become, as it were, invisible. At one place, for example, there is free metal, but at another -- rolling capacities are in surplus. This means that it is simply necessary to transfer the metal to a place where it can be turned into ready rolled goods.

In real life everything is much more complicated. Irrational hauls of metal and billets from one enterprise to another create enormous strains on our main transportation arteries which are already overloaded. Overhead costs lie as a heavy burden on the cost of final output. Great difficulties are experienced by plants which are compelled to operate helter-skelter. The way of solving this basic problem is pointed out in the decree of the CC CPSU and USSR Council of Ministers: an efficient combination of the principles of branch and territorial planning. With respect to ferrous metallurgy this sounds, I dare say, especially topical. [22-2959]

7019
CSO: 1842

DIFFICULTIES CITED IN INTRODUCING SCIENTIFIC ACHIEVEMENTS

Kiev RABOCHAYA GAZETA in Russian No 235, 12 Oct 79 p 2

[Article by M. Medvedev, Head of the Chair of Metal-Cutting Machine Tools and Metals Technology, Nikolayev Shipbuilding Institute imeni Admiral S. O. Makarov, Nikolayev: "The Scientific-Production Complex--Concept, Development, Introduction: Eliminate 'Side' Problems"]

[Text] The personnel of the Nikolayev Shipbuilding Institute imeni Admiral S. O. Makarov have long established fruitful links with many industrial enterprises. Our Chair has provided assistance to the Chernomorsk Shipyard in reducing the consumption of tin in alloys and producing lightweight anchor chains. At the Okean plant the introduction of materials with enameled coatings for the finishing of ship interiors was welcomed.

Previously many topics, even when developed in sufficient depth, often got pigeonholed. Their practical application was impeded by unresolved attendant problems. Here is an example: At one time we convincingly demonstrated the effect of various lubricants and coolants on the strength of metal-cutting tools. The enterprises to which this project was proposed were interested. However, the stage of practical application was never reached. Why? Because no one had developed the appropriate industrial technology for the production of the new lubricants and coolants as well as the rules of safety engineering related to their use.

A comprehensive approach to the solution of a problem precludes such difficulties. After all, this is a question of not just one narrow topic but of the complex whole of its consequences, of the solution of attendant problems on which hinges the introduction of the main idea into production.

In this connection, the extensive work which we accomplish at the Pervomaysk Machine Building Plant imeni 25 October is worth describing. That plant produces diesel engines which are needed on ships, in the forest industry, and by geologic prospecting teams. Not so long ago its personnel commenced the production of the new 1,200 HP engine, which has twice as much horsepower as the currently series-built engines.

The coworkers at the Chair of Metal-Cutting Machine Tools and Metals Technology L. P. Klimenko, V. A. Komarov, and others, decided to develop for that plant a new waste-reducing technology of the production of cylinder bushings whose rapid wear results in the shutdown and repair of the engine.

Not everything went smoothly. A number of extraneous difficulties were encountered. In particular, the right kind of iron was found to be lacking, and the necessary production tools were unavailable. Using the experience of the group of experts from the Pervomaysk and Chernomorsk shipyards, the scientists undertook to develop the "recipe" for a complex-alloyed iron. It was developed. It contains only one-third as much of scarce materials.

The new iron requires a new production technology, because the previously used cupola smelting technique could not assure stable properties of the alloy. So we developed a technology for melting the iron in induction furnaces, which not only enhanced the quality of the castings but also sharply reduced atmospheric pollution. And only after that we began to develop our original project--the low-waste technology of the production of bushings. Here the principal factor was the replacement of the pouring of metal into single-use sand molds with the more advanced centrifugal casting performed with the aid of special machinery.

The new cast bushings of complex-alloyed iron were thereupon subjected to special test-stand trials, which showed that then the rated operating life of the engine increased by roughly 30-35 percent. Moreover, the attendant production of each bushing saves as much as 50 kg of metal. And this means that if our bushings are installed in all the engines produced by the Plant imeni 25 October, savings of 1.5 million rubles annually will accrue to the national economy. This figure does not include the savings of time on the machining of the components owing to the reduction in tolerances as well as the lower cost of engine repair. Thus we see that the comprehensive solution of the problem paid off with interest for the effort invested, even though it required a lot of time and resources. Our research has attracted the interest of diesel-engine builders in Kiev, Bryansk and various other cities.

This goal-oriented comprehensive project method has produced positive results in various other cases as well. In particular, it has proved effective in the introduction of an optimal technology for the heat treatment of steel castings and in the development of a heat-resistant alloy with a lower nickel content at the Chernomorsk Plant. And in all such cases the time from the stage of development to the stage of industrial introduction was minimal.

Unfortunately, the successful application of comprehensive scientific research encounters obstacles associated with the erroneous evaluation of the activity of individual production sectors. Thus, for example, the introduction of projects intended to reduce the weight of blanks or to reduce the cost of metal alloys is being delayed because producers settle accounts in terms of "gross" output, inclusive of the cost of raw and other materials, rather than in terms of standard net output. Hence they are not interested in reducing the cost of alloys or reducing the metal machining tolerances.

The future belongs to the comprehensive goal-oriented research method, which offers the "green light" to the introduction of the achievements of science into production.
[17-1286]

1386
CSO: 1842

ECONOMIZING METALS DISCUSSED

Moscow IZVESTIYA in Russian, 20 October 1979, p 2

[Article by N. Ryzhkov, First Deputy Chairman of Gosplan USSR: "Reserves for Economizing Metal"]

[Text] Among the most acute and important economic problems of the present day is the production and economizing of metal. It is precisely upon how well supplied they are with metal that the growth of the branches of our economy depends. We know that metal is now limiting the development of many branches. The task is to plan measures which have to be taken next year and during the 11th Five-Year Plan in order to eliminate the scarcity of metal as much as possible. This task is entirely realistic. The positive examples of certain productions and branches convincingly show how much can be achieved here.

Let us take, for example, the problem of economizing metal in machine building. Our energy machine builders thought about this in creating their new equipment. The specific metal consumption of the vast majority of these types of equipment corresponds to the indicators for similar equipment which is produced abroad. Some of our agricultural machinery is not inferior to contemporary foreign models and, in a number of cases, is superior to them. For example, the specific metal consumption of the Minsk plant's MPZ-80 tractor is much smaller than that of the best foreign analogs.

Attention should be given to the experience of ZIL which has been approved by the CC CPSU. The introduction of low-waste technology in this association is ensuring a decrease in the expenditure of metal of 120,000 tons a year. The average metal use coefficient in producing parts which are shifted to the low-waste technology is .8 percent. The labor intensiveness of the products is decreased to such an extent that around 1500 people can be released.

Rational and efficient methods of obtaining the metal itself are very important. Curvilinear and radial type continuous billet casting machines which were developed for the first time in world practice by our scientists and designers make it possible to economize from 10 to 20 percent of the metal. The experience of the Novolipetsk plant and of the "Azovstal'" metallurgical plant have shown that large oxygen-converter shops which are equipped with 300-350 ton converters and continuous billet casting machines with the capacity of 1 million tons and more operate stably and productively, producing high quality output.

Yes, the problem of metal is by no means a dead end. But it has still not been solved. No matter what our partial successes have been, there has been no fundamental breakthrough in machine building or in metalworking. The metal intensiveness of most of the machinery and equipment we produce continues to be high, metal waste is large, and the use coefficient of metal output is increasing slowly.

Far from all of the ministries and departments are ensuring the fulfillment of metal economy assignments. There are especially large losses at the productions of the Ministry of Motor Vehicle Industry, Ministry of Agricultural Machine Building, and the Ministry of Construction and Road Machine Building.

I will cite examples. The metal consumption of single-scoop domestic excavators (per unit of scoop capacity) is higher than foreign analogs by 6 percent in the best cases, and by 35 percent in the worst, and by 20 to 60 percent per unit of productivity. The specific metal consumption of our scrapers is greater than foreign ones per unit of scoop capacity by [illegible] to 29 percent. An extremely large amount of metal is also expended for our forging and pressing machines, motor vehicles, cisterns, and equipment for the light and food industries.

There are extremely large losses of finished metal rolled goods, or, to put it another way, a large amount of it goes into waste. In 1970 the use coefficient of rolled ferrous metals was .70, and eight years later in 1978, it was only possible to increase it to .728. This means that around one-third of the metal which has been converted with enormous expenditures of labor into high quality rolled goods, must again be smelted by enterprises.

There are extremely large losses at the enterprises of the Ministry of Machine Tool Industry, Ministry of Electrical Engineering Industry, Ministry of Motor Vehicle Industry, and the Ministry of Chemical Machine Building. According to the data of the USSR Central Statistical Administration, for ferrous metals as a whole (including steel and iron castings) in 1978 waste at 11 machine building ministries came to around 12 million tons, including around 6 million tons which went into shavings.

Unfortunately, it has to be admitted that there are more than one or two reasons for the loss of metal. There are several very serious directions in which it is necessary to work in order to achieve success.

For example, metallurgy is still producing very few economical cold-bent and hot-rolled sections for machine building in construction. The number of type sizes of rolled metal sections which is produced by our industry is almost one-half of the need for them. It is for this reason that the percentage of the economy of rolled goods for this factor is so low. It does not come to 60 percent. In addition, ferrous metallurgy enterprises are unjustifiably delaying the production of new economical types of sections which have been agreed upon with them, thereby lowering the efficiency of machine building production.

There are also examples of a different character. The USSR Ministry of Ferrous Metallurgy has been mastering the progressive production of new rolled goods sections, but this is not leading to success either. The sections are not being used by those consumers who made requisitions for them. For example, at the Nizhnetagil' Metallurgical Combine a unique shop has been put into operation for the production of beams; it is equipped with modern equipment which was designed and produced by the Urals Machinery Plant. According to the calculations of the USSR Ministry of Ferrous Metallurgy, the use of these sections in the economy and, above all, in construction makes it possible to have an annual economic effect of 19.8 million rubles. However, the mill's workload for 1980 -- the third year of the shop's operations -- comes to only 70 percent of its capacity. Such is the sad result of lack of coordination. Gosstroy USSR, the USSR Ministry of Installation and Special Construction Work, and the planning institutes of machine building and construction organizations were late in reviewing the designs in effect, the planning norms, and other technical documentation. This is why the role of well-conceived detailed planning is so important.

There was a special examination of the problem of improving the use of rolled metal goods in machine building in Gosplan USSR and a decision was made -- beginning with 1980 to stipulate an assignment on improving the use coefficient of rolled ferrous metals, and of other types of metal output in subsequent years. In our opinion, this will compel economic executives to have a new look at certain harmful regulations which have taken root, especially in production technology. When the five-year and annual plans are made up Gosplan USSR together with the USSR Ministry of Ferrous Metallurgy and Machine Building Ministries do special work to develop overall programs for the introduction of low-waste technologies, and a section on the development of progressive metal output is carefully worked out. This makes it possible to provide for a sufficiently high percentage of metal output economies in the plans of machine building ministries.

It has to be said that precise planning is an essential, but an insufficient condition for the complete solution of the problem of metal. It is necessary for these plans to be carried out to the last detail. Today they are not met at many productions.

The effectiveness of the use of exothermic mixtures and heat-insulation inserts in steel casting is clear to everybody. (Their use makes it possible to economize not less than 3 percent of the metal.) Nevertheless, to this day the USSR Ministry of Metallurgy has not organized the production of heat-insulation inserts and exothermic mixtures and their introduction at the leading enterprises of ferrous metallurgy.

The introduction of a continuous steel smelting technology is one of the most important reserves for economizing metal. This progressive technology long ago justified itself. However, the ratesof its introduction are still slow. It should be said that in developing the plans for the development of ferrous metallurgy for the 11th Five-Year Plan priority will be given to this direction. The workers of ferrous metallurgy and heavy machine building will have to urgently solve all of the problems which are holding back the wide-scale use of continuous steel smelting.

Capital construction has enormous unutilized reserves for economizing metal. New effective structures are being introduced slowly here, and there is an unjustified use of steel structures in places where it is not necessary and where it would be possible to use substitute materials -- plastic, plywood.

There are large losses of rolled metal goods in construction when metal structures are made at the construction sites themselves and not under planned conditions. The metal control and inventory level at construction sites is low.

The decree of the CC CPSU and USSR Council of Ministers "On Improving Planning and Strengthening the Influence of the Economic Mechanism on Increasing Production Efficiency and Improving the Quality of Work" will play a very important role in solving the problem of metal. This decree stipulates that special-purpose overall programs will be included in the state plans. The development of programs for economizing fuel and metal has been scheduled with a top priority.

The measures which will inevitably go into this program can already be named today. First of all, the introduction of a progressive structure for steel smelting production. Powerful converters and machines for continuous billet casting will be the chief direction.

An improvement of the consumer properties of metal makes it possible to obtain more rolled metal goods from the same quantity of ore and coal. The role of the so-called fourth conversion is important here.

The production of tin may be cited as an example. In foreign countries tin with a thickness of .08 millimeters is produced for the making of many types of cans, while in our country the thickness is .23 milimeters. If the average thickness is decreased to at least .18 milimeters, this will produce an annual economy of metal of around 280,000 tons. This is what is provided by an improvement of consumer properties.

I would like to consider certain factors which have a large influence on the efficient consumption of metal in machine building. The fate of metal intensiveness is above all in the hands of the designer. It is designing thought that has to dictate the mastery and production of progressive types of construction materials and, especially, of metal.

Practice shows that the creation of a mechanism or machine is produced by various design decisions. Under these conditions, special attention has to be given to an improvement of technical specifications and to the designing of machines. In this connection, the role of standardization is important, since it is state or branch standards that should reflect the requirements for the specific metal intensiveness of output of the same type which are mandatory in the creation of new models or the modernization of models which are being produced. The specific metal intensiveness indicator has to be one of the basic ones in considering the design of a machine and deciding to put it into production.

The designer and the production engineer decide upon the rational types of billets. Experience shows that the use of cast billets instead of welded structures makes machines 20 to 30 percent heavier and increases the labor intensiveness of machining. In the metallurgical machine building of the Ministry of Heavy Machine Building the proportion of cast billets comes to 55 percent, while in electrical engineering machine building it is 20 percent. This is substantially more than in other developed countries: There this proportion comes to 30 and 10 percent, respectively.

In view of the difficulties connected with supplying metal rolled goods, special-programs for the planned reduction of the proportion of cast billets have to be worked out in the machine building ministries; this, in the final analysis, will produce an economic effect in the economy.

Special attention is devoted to technological measures in the overall machine building program. There are supposed to be outstripping rates for the development of progressive types of technological processes -- such processes as stamping on presses, precision casting, and gas cutting. Especial attention will be given to low-waste technology.

The problem of the development of the latest methods of working metal with pressure is being introduced into future plans. New methods of rolling in machine building which have been developed at the All-Union Scientific Research Institute of Metallurgical Machine Building have to be numbered, first of all, among these methods. Special attention is merited by mills for rolling hollow beams and gear wheels and mills for the transverse-screw rolling of mass parts.

Machine building ministries have to direct their attention to equipment which is very much needed by them and which cannot be produced in a series manner. Correct actions are being taken by the Ministry of Motor Vehicle Industry and the Ministry of Electrical Engineering Industry which are working purposefully on the creation of their own production of highly productive machinery and equipment for their own branches. Since they are very mobile and efficient, such productions are capable of rapidly satisfying production needs which arise.

Powder metallurgy will become widespread in machine building and metal working. In addition to doubling the economy of metal in machining 1,000 tons of parts which are produced by this method, 190 highly skilled workers and 80 metal-working machine tools are freed. It is essential for machine building ministries to develop special-purpose programs for the extensive introduction of this progressive method.

Shifting the smelting of iron from cupolas to electro-furnaces makes it possible to increase the strength characteristics of castings by 1.5 to 2 times and, correspondingly, to decrease the expenditure of blast furnace iron and use it for the production of rolled goods. Measures for the extensive introduction of the electro-furnaces have to be put in the technical reconstruction plans of the iron casting shops of machine building plants during the 11th Five-Year Plan.

The successful realization of the tasks which have been set by the 25th Party Congress in the field of increasing production efficiency and economizing metals and the realization of the proposals and conclusions contained in the speeches of Comrade L. I. Brezhnev will be determined above all by the level or organizational and political work in the ministries, associations, enterprises, and in the scientific research and planning organizations of industry and construction.

It is here that the attention of designers, production engineers, economists, production leaders, and scientists has to be concentrated. A situation has to be achieved in which a thorough economy of metal will become an organic component part of socialist competition.
[21-2959]

2959
CSO: 1842

NEW CHEMICAL METALLIZATION METHOD DESCRIBED

Moscow PRAVDA in Russian 16 Oct 1979, p. 4.

[Article by G. Lebanidze: "Instead of Gold"]

[Text] Among the models of products which have been introduced by this collective into production, the display stands in the hall of the Institute of Metallurgy of the Academy of Sciences of the Georgian SSR contain ceramic condensers. Some of them are silverplated. Others have a cheaper nickel-phosphorous plating. In the second case a simple and widely accessible method is used which was developed by the metallization laboratory under the direction of Doctor of Technical Sciences T. Khoperiy. And it turns out that in their electrical characteristics these parts are in no way inferior to their "silver colleagues."

The metallization of glass, ceramics, piezoceramics, quartz, semiconductors, plastic, and other non-metallic materials is finding an increasingly wide application in the world practice of machine building, instrument making, electrical engineering and other branches of industry. In order to obtain an especially high electrical characteristic, products are plated with gold and silver. In this process there are substantial losses of precious metals, very long technological cycles, and a high level of labor intensiveness and expensive equipment is needed.

The new method of chemical metallization is extremely simple. The salts of the appropriate metals and their restorers are dissolved in water. Reactions begin as a result of which a pure metal or an alloy of an assigned composition is put on the surface which is being covered. When necessary, it is possible to plate parts selectively; for example, to place on the surface of a part a current conducting line with a width which is measured in microns. The method also makes it possible to unite non-metallic parts with metallic ones, to produce a decorative finish, and to create metal film with assigned properties and with various electrical, magnetic, and other characteristics. The technology which has been developed is also applicable in the production of quartz resonators, piezoceramic emitters, condensers, circuits for computer equipment, and in many other cases.

The important merit of the method is that it makes it possible to metallize parts in large batches. This sharply increases labor productivity and makes the process much less expensive. But, most important, it is possible to plate parts with a nickel-phosphorous alloy instead of silver and gold without worsening, and in many cases, with an improvement of their operational characteristics.

The progressive method has received wide recognition. It is being successfully used in series production in the Soviet Union and has been patented in England, the FRG, France, and other countries.
[20-2959]

2959
CSO: 1842

USSR UDC 669.15'24'295:539.389.2

EFFECT OF THE HARDENING OF Fe-Ni-Ti ALLOYS ON THEIR SHAPE MEMORY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 6, 1979
pp 1288-1293 manuscript received 7 Jun 78; after editing 17 Oct 78

KOVAL', YU. N., MUSIYENKO, R. YA. and KHANDROS, L. G., Institute of Metal Physics, Academy of Sciences UkrSSR

[Abstract] Fe-Ni alloys when heated tend to recover their original shape, like other alloys with reversible martensitic transformation. However, unlike the alloys containing thermoelastic martensite, they recover their shape only partially--25-30%, after being subject to bending at three points. One reason for such incomplete recovery of shape is that the process of straining within the temperature range of martensitic transformation occurs owing to slip (formation and migration of dislocations). The plastic deformation associated with the movement of dislocations can be reduced if the matrix is in some way hardened, and then the degree of recovery of shape should increase. This assumption was tested by treating a Fe-Ni alloy with 3% Ti, age-hardening it at 750°C for 30 min, and subjecting it to five or six heating and cooling cycles, after subjecting specimens of the alloy to three-point bending at room temperature. The shape recovery then achieved reached ∿90-100%. Figures 5; references 11: 8 Russian, 3 Western.
[178-1386]

USSR UDC 54.185:669

EFFECT OF NEUTRON IRRADIATION ON THE STRUCTURE AND PROPERTIES OF CARBON FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, 1979 pp 14-18 manuscript received 26 Jul 77

LIGACHEVA, YE. A., KOSTIKOV, V. I. and SKRIPCHENKO, G. B., Moscow

[Abstract] The effect of fast neutron irradiation ($E>0.18$ MeV) at 420 and 550°C on the structure and mechanical properties of carbon fibers produced from polyacrylonitrile was investigated. That irradiation is found to have a dual effect, depending on the irradiation dose. At lower doses (10^{14}-10^{15} n/cm^2) internal stresses in the fibers get relaxed and the structure becomes more homogeneous, which apparently is due to the straightening of microfibrils and the increase in the extent of the preferred orientation of the

fibers. At doses of 10^{15}-10^{18} n/cm^2 the structure is inhomogeneous, fiber orientation becomes random, and internal stresses increase. Irradiation markedly affects the mechanical properties of the carbon fibers. At doses of >15 n/cm^2, when internal stresses are higher and the structural defects of the fibers increase owing to the dislodging of carbon atoms from crystal lattice nodes, the Young's modulus and tensile strength of the fibers increase markedly. Subsequent annealing of the irradiated fibers at 1000, 1500, and 1700°C reduces their internal stresses and virtually restores their preferred orientation. Figures 3; references 8: 3 Russian, 5 Western.
[173-1386]

USSR UDC 535.211

ON A POSSIBLE MECHANISM OF THE ABSORPTION OF LASER RADIATION BY THE SURFACE-LAYER DEFECTS OF A SOLID TRANSPORT DIELECTRIC

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, 1979 pp 37-41 manuscript received 25 Dec 78

BABADZHAN, YE. I., KOSACHEV, V. V. and LOKHOV, YU. N., Moscow

[Abstract] Damage to the surface of transparent dielectrics by a laser pulse may be associated with the presence of absorbing centers such as homogeneous inclusions whose presence in the surface layer of the dielectric is due to technological reasons. In this connection the theoretical mechanism of absorption of the energy of a laser pulse acting on a defect-containing dielectric surface is investigated. The pulse duration is assumed to be several nanoseconds, the radiation intensity ~ 10 Gwatt/cm^2, and the wavelength $\lambda = 1.06$ μm. The pulse is applied to an optical surface whose machining (grinding, polishing) causes it to form a cracked polycrystalline layer. In the defect-containing regions of that layer with a plane defect concentration of $\sim 10^6$ cm^{-1} absorption of laser radiation by conduction electrons may occur owing to collisions between electrons and microdefects. The absorption center, which has an electron concentration of $\sim 10^{21}$ cm^{-3} and an absorption factor of $\sim 10^4$-10^5 cm^{-1}, represents a source of electron-hole plasma and, as such, it markedly accelerates the increase in the electron concentration and temperature of the adjoining layers of the dielectric. At intensities of ≥ 10 Gwatt/cm^2 this may result in the melting and evaporation of a part of the dielectric measuring 1.5--2 μm in area within ~ 7 nanoseconds. References 9: 7 Russian, 2 Western.
[173-1386]

USSR UDC 535.21

USE OF A CONICAL LENS TO PRODUCE LARGE-DIAMETER ORIFICES WITH THE AID OF A LASER BEAM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, 1979 pp 145-147 manuscript received 8 Apr 77

KOKORA, A. N., KORNEYEV, YE. A., MANZON, B. M. and OREKHOV, M. V., Moscow

[Abstract] The drilling of orifices exceeding 1 mm in diameter by means of lasers normally requires considerable pulse energies. In this connection, to reduce such energies and make the method more technological, a procedure for laser drilling large-diameter orifices, consisting in the moving of components in such a manner that the focal point of the optical system would describe the required contour, is proposed. The beam is shaped in accordance with the dimensions and contour of the orifice and then directed at the material to be drilled. To this end, a conical lens is also used in the optical system. A formula relating the distance from the optical axis to the contour point in a plane passing through the optical axis, to the angle between the generatrix of the conical surface and the optical axis in the same plane is presented. The method was used to drill orifices of 2.5 mm diameter in 0.3 mm stainless steel, with a laser energy output of 16 joules (pulse duration 1.0 msec), with each pulse dissected into 10 micropulses 40 μsec long each. Orifices of 2.5 mm diameter were drilled by this method in 1.2-mm-thick ferrite specimens, with similar success. This new method can be used to drill orifices of more than 1-mm-diameter in components such as filters, meshes, and many others. Figures 4; references 1 (Russian).
[173-1386]

USSR UDC 621.746:536.12

CONCERNING CALCULATION OF THE TEMPERATURE FIELD OF THINWALLED SHELL MOLDS ACCORDING TO VACUUM-CAST WAX PATTERNS

Moscow IVUZ. CHERNAYA METALLURGIYA in Russian No 7, 1979 pp 124-129 manuscript received 19 Dec 77

MAMLEYEV, R. F., TSIREL'MAN, N. M., SHPINDLER, S. S., LANDA, M. I. and NEUSTRUYEV, A. A., Ufa Aviation Institute imeni Ordzhonikidze

[Abstract] Analytic calculations of the process of solidification of a casting as well as estimation of thermal stresses in a thinwalled shell mold lacking a filler core entail the problem of determining the temperature field of the mold. In vacuum casting, heat transfer from the outer surface of such a mold follows the pattern of radiation in the presence of nonlinear boundary conditions, which complicates achieving an exact solution of the problem. In

connection, approximate analytic calculations of the temperature field of molds of this kind in vacuum casting are presented. The boundary-value problem for unsteady-state heat conduction in thinwalled molds is formulated as a problem of the distribution of the function $\ln U (\eta, \tau)$ over the thickness of an unbounded plate in time with modified convective heat transfer at one surface of that plate. The theoretical findings were found to be in agreement with experimental calculations of temperature distribution over the cross section of 8-9-layer cylindrical wax-pattern shell molds of corundum-sillimanite and silica, and thus are useful to determining the solidification time of castings. Figures 3; references 4 (Russian).
[177-1386]

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BASIC FEATURES OF ELECTRIC-SPARK PRECISION TREATMENT OF MATERIALS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 4, Jul/Aug 79 pp 5-9

STAVITSKAYA, N. B. and STAVITSKIY, B. I., Moscow

[Abstract] The electric-spark process is used for precision treatment of miniature and intricate parts made of any conducting material with a fine surface finish. Here the basic features of this operation are analyzed on the basis of relations between various process parameters and consideration of various influencing factors. One process characteristic is the dependence of the crater dimensions, its diameter and depth, on the energy of a microsecond discharge spark by which craters are produced in the electrodes. Another process characteristic is the dependence of the volume of the removed material on the interelectrode distance. Furthermore, the size of burrs at the surface edges depends on the power density of a discharge pulse. Accordingly, there is a range of pulse energy with which any degree of surface roughness can be attained. The pulse energy should be low, but the power density over the short pulse duration should be high for optimum surface finish. The process is influenced by erosion of the electrodes, which also depends on the medium occupying the interelectrode gap, and by the manner with which the erosion products are removed from the treatment zone. Using distilled or tap water and continuously maintaining normal, natural conditions for removal of particles, with reduced interaction between electrodes and with the shortest possible path for the particles to travel through, will ensure successful precision treatment. Figures 1; references 14 (Russian).
[1-2415]

USSR UDC 539.4

EVALUATION OF SOME GENERAL FEATURES OF LONG-TERM WEAKENING OF INDIVIDUAL CLASSES OF HIGH-TEMPERATURE MATERIALS

Kiev PROBLEMY PROCHNOSTI in Russian No 5, 1979 pp 34-37 manuscript received 15 May 78

KRIVENYUK, V. V. and ZELENYUK, YE. YE., Kiev, Institute of Problems of Strength, Academy of Sciences Ukrainian SSR

[Abstract] This study documents the fact that the magnitude of decrease in long-term stability may be evaluated from experiments over limited time intervals and that the results of short-term evaluation may be considered as being related to the long-term weakening. This parameter may be used to predict long-term high-temperature creep. The study includes consideration of the different structural components associated with strengthening and also of the quantitative correlations between the micro- and macrostructural properties. Both short-term and long-term weakening are considered. A graph is constructed of the relationship between the short-term (vertical axis) and long-term (horizontal axis) strength for different time durations from 100 to 200,000 hours. Calculations of this parameter may provide a more accurate means for rapidly evaluating the thermal limits of materials. Figures 3; references 9: 3 Western, 6 Russian.

USSR UDC 539.388.1

INFLUENCE OF HIGH-TEMPERATURE AGE HARDENING IN VACUUM ON THE CREEP OF 5VMTS ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 5, 1979 pp 40-43 manuscript received 15 May 78

KISSIL', A. YE., LYUTYY, YE. M., KHANDAROV, P. A., ABAKELOV, A. G., MAKSIMOVICH, G. G., ONISENKO, L. P. and TSVIKILEVICH, O. S., L'vov, Physical-Mechanical Institute, Academy of Sciences UkrSSR

[Abstract] A study was made to evaluate the influence of temperature and stress on the high-temperature stability of a niobium alloy. The samples were heated in vacuum to temperatures of 900 - 1100°C for 100, 500, 1000, and 5000 hours in both the stressed and unstressed states. The long-term strength decreases both with increasing temperature and with increasing time. The data also show that the rate of steady-state creep ε is a function of the stress both in the original material and in the thermally treated

material. It may be described by the equation

$$\varepsilon = A\exp(\beta\sigma)$$

where β is a coefficient proportional to the activation volume and is a characteristic structural property of the material; δ is the strength. For the 5VMTS alloy, $\beta = 0.79$ mm^2/kg for the untreated material; that for the sample heated to 900°C for 1000 hours was virtually the same. Heating at 900°C for 5000 hours reduced the value of β to 0.56 for the sample under stress and to 0.44 mm^2/kg for the sample with no load. Figures 3; references 5 (Russian).

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